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Technical Report RSC-47

REMOTE MEASUREMENT OF TURBIDITY AND CHLOROPHYLL THROUGH AERIAL PHOTOGRAPHY

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by

Martin David Schwebel
Dr. Wesley P. James
&
Dr. William J. Clark

December 1973

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TEXAS A&M UNIVERSITY
REMOTE SENSING CENTER
COLLEGE STATION, TEXAS

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ABSTRACT

Remote Measurement of Turbidity and Chlorophyll Through Aerial Photography

Studies were conducted utilizing six different film and filter combinations to quantitatively detect chlorophyll and turbidity in six farm ponds. The low range of turbidity from 0-35 JTU correlated well with the density readings from the green band of normal color film and the high range above 35 JTU was found to correlate with density readings in the red band of color infrared film. The effect of many of the significant variables can be reduced by using standardized procedures in taking the photography.

Attempts to detect chlorophyll were masked by the turbidity. The ponds which were highly turbid also had high chlorophyll concentrations; whereas, the ponds with low turbiidty also had low chlorophyll concentrations. This prevented a direct correlation for this parameter.

Several suggested approaches are cited for possible future investigations.

ACKNOWLEDGEMENT

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INTRODUCTION

Need for Monitoring

Effective remote measurement of aquatic ecosystem parameters is a highly desirable goal. Where only ground visits are used, limitations are placed upon the investigator as to number of sites and frequency of sampling.

A synoptic overview of many aquatic systems is often desired by the ecologist studying energetics and by agencies whose job it is to monitor water quality. Information of this nature can be valuable to state Fish & Game agencies as well as to the federal government. It could provide an estimate of a pond or lake's productivity and hence its ability to support fish life. Finally, remote sensing can be a valuable tool in resource management. Sources of excess nutrient enrichment can be pinpointed and effective control measures can be instituted.

Turbidity and Chlorophyll

Turbidity is the effect of suspended material in the water column on light penetration. This suspended

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This thesis follows the format and style of Limnology and Oceanography.

material includes clay and silt particles as well as planktonic organisms. Turbidity is one component of the light attenuation process of a body of water. The other component, true color, is that color remaining after filtration and/or centrifugation. True color is naturally imparted by dissolved materials, inorganic and organic. Deeply stained waters can also result from industrial effluents -- especially from the beet canning industry, paper pulp industry and textile dyeing operations.

Phytoplankton populations are of considerable interest. These microscopic organisms are primary producers; chlorophyll containing plants which form the first step in the food chain of most lacustrine aquatic ecosystems. Planktonic organisms are by definition free floating and more or less dependent upon wind and wave actions to maintain their positions in the water column. These organisms are equipped with a variety of morphological adaptations to aide in maintaining their position in the water.

If chlorophyll can be measured, an index of photosynthetic activity can be obtained.

Conventional Methods of Measurement

Turbidity is usually measured by some means comparable

to the accepted standard -- the Jackson candle turbidimeter. The Jackson candle turbidimeter consist of a long glass cylinder graduated in Jackson turbidity units. The light from a standard candle is supplied from below and the observer watches for the extinction of the image of the flame as the sample of turbid water is poured into the tube. The reading is taken from the side markings. One of the best instruments available for turbidity measurement is the nephelometer. This electronic instrument measures light scatter through a sample of fixed size. The unit employs a light source which shines through the sample and a photo receptor cell at right angles to the axis of the light. The photo receptor thus measures only the light scattered from particles in the sample. The standards for calibrating this instrument are prepared from a standard formazine solution which has a relationship to the Jackson Units (Hach, 1972). The resulting formazine turbidity units (FTU) are numerically identical to the Jackson turbidity units (JTU).

Chlorophyll in phytoplankton is usually measured by filtering the organisms onto a membrane filter which is dissolved in acetone. Readings are taken on a spectrophotometer at three specific wavelengths 630 nm, 645 nm and 665 nm. The optical density values for each sample are then inserted into the equations which calculate

chlorophyll in weight units/volume. An additional reading is usually taken at 750 nm. This is a correction factor for the turbidity of the sample. The value is subtracted from the other readings before the calculations are performed.

Aerial Photography

Aerial photography is not limited to the determination of size and position of objects, as in normal photogrammetry, but can also be used as an energy sensor. The amount of light reflected from the water surface or water column is recorded by the film as film density and can be quantitatively measured with a photo-densitometer. The composition of the reflected light can be determined by varying film-filter combinations.

Special film and filters are usually used in aerial photography work to reduce interference and to enhance the contrast between objects. However, many of these films are not available in the 35 mm format. Filters play the primary role in enabling one to use the 35 mm size films. In order to properly select the best film and filter combinations, the researcher should carefully study the available transmittance curves published by the manufacturers. Sensitivity curves are also available for film.

Objectives

It has been the objective of this study to develop an economical technique for quantitative measurement of chlorophyll and turbidity values in water using 35 mm aerial photography.

LITERATURE REVIEW

Cole (1963) states that the many man-made reservoirs and ponds in Texas cover more than 283,000 hectares. Other unpublished data by Clark and Schwebel (personal communication) indicate that there are more than 2,000 of these structures in Brazos County, Texas alone. Meyers (1973) in his description of the physical limnology of eighteen farm ponds, included five of the six ponds used in this study. Respes, et al. (1972) added a figure of over 500,000 farm ponds to the general information about Texas lakes and ponds. They also present the physical characteristics of the sixth study pond.

Chlorophyll and turbidity are two indicators of the relative state of enrichment of a pond or lake. Yentsch (1960) reports marine experiments with a submarine spectrometer. He demonstrated that phytoplankton cause a differential absorption of light. It is especially noteworthy that these experiments were conducted in turbid conditions as well as in fairly clear waters. Yentsch shows curves for several populations, both cultured and natural. There appears to be little difference in any of the absorption maxima and minima. The combined pigments--chlorophylls and carotenoids--show strong absorption

in the blue range around 400 - 500 nm, and another absorption peak from 650 - 680 nm. The latter has been shown to be due exclusively to chlorophyll a. Yentsch's curves for typical chlorophyll a absorption and transmission are vital for the selection of the appropriate filters for a multiband camera arrangement.

Chlorophyll studies have also been made with other types of instrumentation.

Spectrometer measurements have been made from both research vessels at sea and research aircraft (Clarke, Ewing, and Lorenzen, 1970). This instrumentation receives reflected light energy and translates it into an electrical signal which can be recorded as a line graph throughout the spectral range of the instrument. Other investigators, such as Arvensen, Millard and Weaver (1971) have conducted experiments with both the scanning spectrometer and a differential radiometer. The latter instrument is based on a correlation between absorption maxima and absorption minima. In each case, the equipment is very expensive and extremely hard to acquire.

Unlike the double peaked absorption curve of chlorophyll, turbidity is not very wave-length dependent.

Aerial photography has been used in connection with aquatic studies for some time. Hom (1968) describes remote sensing activities in both the photographic and

non-photographic areas. This work is particularly significant in that it deals with water pollution detection. The techniques described include color infrared photography and multi-band photography which are useful in distinguishing water clarity and shoreline configurations. Hom's use of color infrared photography appeared to be limited to qualitative detection of algal growths. Lorenzen (1970) shows a relationship between surface chlorophyll measurements as an index of chlorophyll and primary productivity of the euphotic zone.

Parsons and Strickland (1963) devised equations for estimating chlorophyll a by inserting optical density (O.D.) readings at 630, 645, and 665 nm and correcting for the volume of the sample and light path. Talling and Driver (1963) have determined an approximate equation for estimating chlorophyll a in the absence of degradation products. This equation utilizes only the O.D. reading at 665 nm.

Hach (1972) offers a thorough discussion of the Jackson candle turbidimeter and some of the current instrumentation available for the detection of turbidity. He indicates a greater accuracy in the low ranges with the use of a nephelometer-type detector.

Burgess and James (1971) present an adequate rationale for the use of aerial photography for detecting

scattered light. Their study utilized light scatter from within the water to determine the waste concentration in an effluent plume. The amount of light was recorded as film density and the composition was determined by film and filter combinations. They further stated that light scattering or light absorption properties of a waste plume are a function of the wavelength of light. The ratio of light return in the bands of maximum absorption and minimum absorption was a sensitive indicator of concentration.

The two general types of filters used in water quality studies are the absorption and interference filters. Kodak Wratten filters are common absorption filters. These filters absorb the light that is not transmitted through the filter. Each filter has its own light transmittance curve.

Interference filters reflect the light that is not transmitted through the filter. They have the advantage over absorption filters in that they can be made with a high light transmittance for a narrow pass band. The wavelength of maximum transmittance for the light varies with the angle that a light ray makes with the normal axis of the filter. This limits the use of interference filters to narrow angles about the camera axis. manufacturers usually provide manuals that show

the transmittance curves for their current filter types such as those of Eastman Kodak (1970) and Tiffen (1964).

All aerial film does not respond the same to light. It will take more light to cause a certain tonal change or change in film density in some wavelength bands than others. The film's sensitivity to the light is a function of the wavelength. The infrared film is sensitive to both the short wavelength light and the longer infrared light. Hence a filter is always used with the film to eliminate the short wavelength light. When selecting film filter combinations, both the light transmittance of the filter and the film's sensitivity must be considered.

High contrast films are normally employed in aerial photography because of the subdued appearance of the terrain as viewed from the air. The light scatter in the atmosphere reduces the contrast between objects. To enhance the scene contrast, high contrast film is used; often along with a yellow or minus blue filter since the blue light is scattered the most in the atmosphere.

Film characteristic curves are available from the manufacturer (Eastman Kodak 1967 & 1969). These curves are plots of film density versus the log of the exposure. The steeper the slope, the greater the contrast and the more critical the exposure setting on the camera. Contrast varies with the type of film and can be modified by the

type of development and the length of development time. High contrast film permits detection of small tonal differences in water masses.

Forsgard and Whittemore (1968) and Eastman Kodak (1968) describe color film characteristics in the Manual of Color Aerial Photography. Color Photography records the light reflected from objects in three bands: blue, green, and red. The film is composed of three light sensitive layers on a thin base. An anti-halation layer prevents light from reflecting from the base back into the emulsion layers.

Because of its higher resolution and better color balance, positive color transparency film is preferred to color prints for photographic analysis. Color in the positive transparency is formed by a subtractive process. Dye formers are in each of the layers and the resulting dye in each layer is inversely proportional to the light exposure in that band. For example the blue sensitive layer contains a yellow color former. A yellow filter transmits all light except blue. The denser the yellow in the film the less blue light is transmitted through the film. The same principle is true for the other two layers - magenta color is minus green and cyan is minus red.

Color films are not designed to reproduce the spectral

characteristics of an object but to reproduce a normal natural ground scene that is visually similar to the original view. For scenes other than natural vegetation, the three bands may not be exposed properly to yield maximum information. When photographing water, generally, the blue sensitive layer is overexposed, the green layer is exposed correctly, and the red sensitive layer is underexposed. If the film is to be used for studying natural suspended sediments in the water column the film should have a higher sensitivity in the red band.

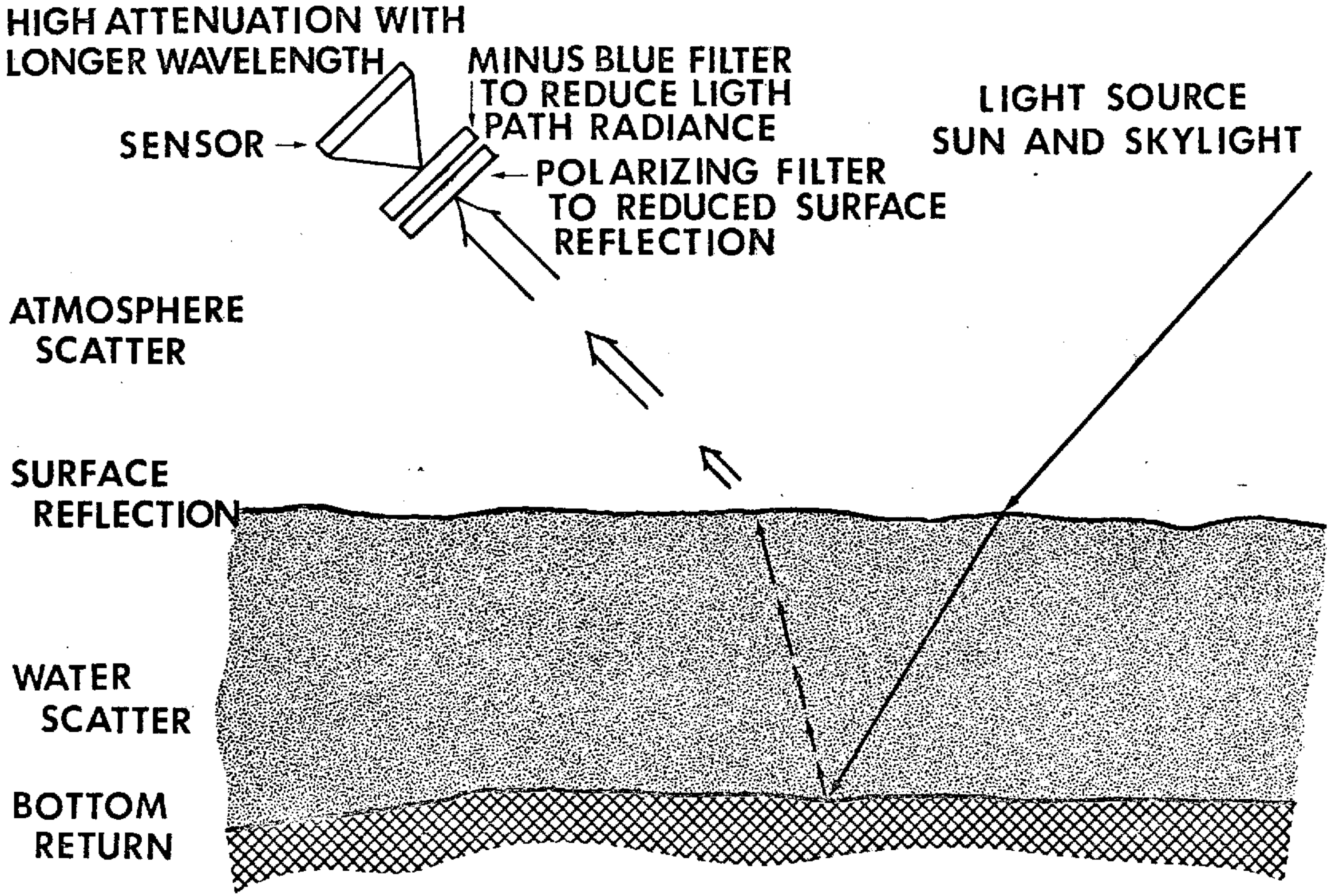
A multiband photographic system has advantages over color photography in that special film and filters can be selected by the user for a specific application. This is especially important in aquatic studies since color film is not designed to record detail changes within a water body but is designed for normal land scenes. With a multiband photographic system the exposures can be adjusted on each band to give the optimum results. Generally for a specific application, two bands give essentially all the information required.

James and Schwebel (1972) in their survey of remote sensing techniques as applied to aquatic studies, had the following comments about light and its interaction with a body of water: Some of the light is scattered and absorbed as it passes through the atmosphere. As a result,

incident light at the water surface includes both direct sunlight and skylight. Skylight is blue for a clear sky but may be nearly white when the atmosphere is hazy or the sky cloudy. The intensity and composition of the direct lighting also varies with the time of day or sun altitude and atmospheric composition.

As shown in Figure 1, the return light that reaches the airborne sensor can include energy reflected from within the water, reflected light from the water surface, and light path radiance in the atmosphere. Since light scattered in the atmosphere is predominently blue, the effect of light path radiance can also be reduced by using a minus blue or yellow filter on the camera.
The subsurface light may include both return from the volume scattering within the water and reflection from the bottom. The intensity and composition of the light scattered within the water column is related to the characteristics of the suspended and colloidal material in the water. Since the water attenuation rate is a function of the wavelength of light, the bottom return can generally be eliminated by using the longer wavelength of bands. The reflected light from the water surface will be partially polarized parallel to the horizon while the light from below the water surface will be partially polarized normal to the horizon. Hence a polarizing

Figure 1. Sources of light returned from water.


HIGH ATTENUATION WITH
LONGER WAVELENGTH
MINUS BLUE FILTER
TO REDUCE LIGTH
PATH RADIANCE
LIGHT SOURCE
SUN AND SKYLIGHT
SENSOR
POLARIZING FILTER
TO REDUCED SURFACE
REFLECTION
ATMOSPHERE
SCATTER
SURFACE
REFLECTION
WATER
SCATTER
BOTTOM
RETURN

filter can be used to maximize or minimize the light return from the surface of the water or from within the water column. In general, direct sunlight reflection from the water surface should be avoided in aquatic studies.

MATERIALS AND METHODS

A program of coordinated field sampling and aerial photography overflights was conducted between May 3, 1973, and July 13, 1973. The sampling program was designed to establish a relationship between chlorophyll and turbidity in farm ponds and light values recorded on film.

Description of Study Area

The six ponds used in this study are located approximately four miles south of the Texas A&M University campus in College Station, Texas. Five ponds are located on privately owned land, and the sixth on the University's Range and Forestry research area. The ponds were chosen for several reasons: their proximity to one another, thus facilitating collections, their apparent wide range of turbidities as observed at the site prior to the outset of this investigation, and their accessibility to ground parties and visibility to overflying aircraft. Figure 2 is an excerpt from a map of Brazos County, Texas showing the location of the ponds involved in this study in relation to the Texas A&M University campus. Figure 3 is an aerial photograph of all six ponds taken by the National Aeronautics and Space Administration in April 1973. The scale of the original photography was 1:20,000.

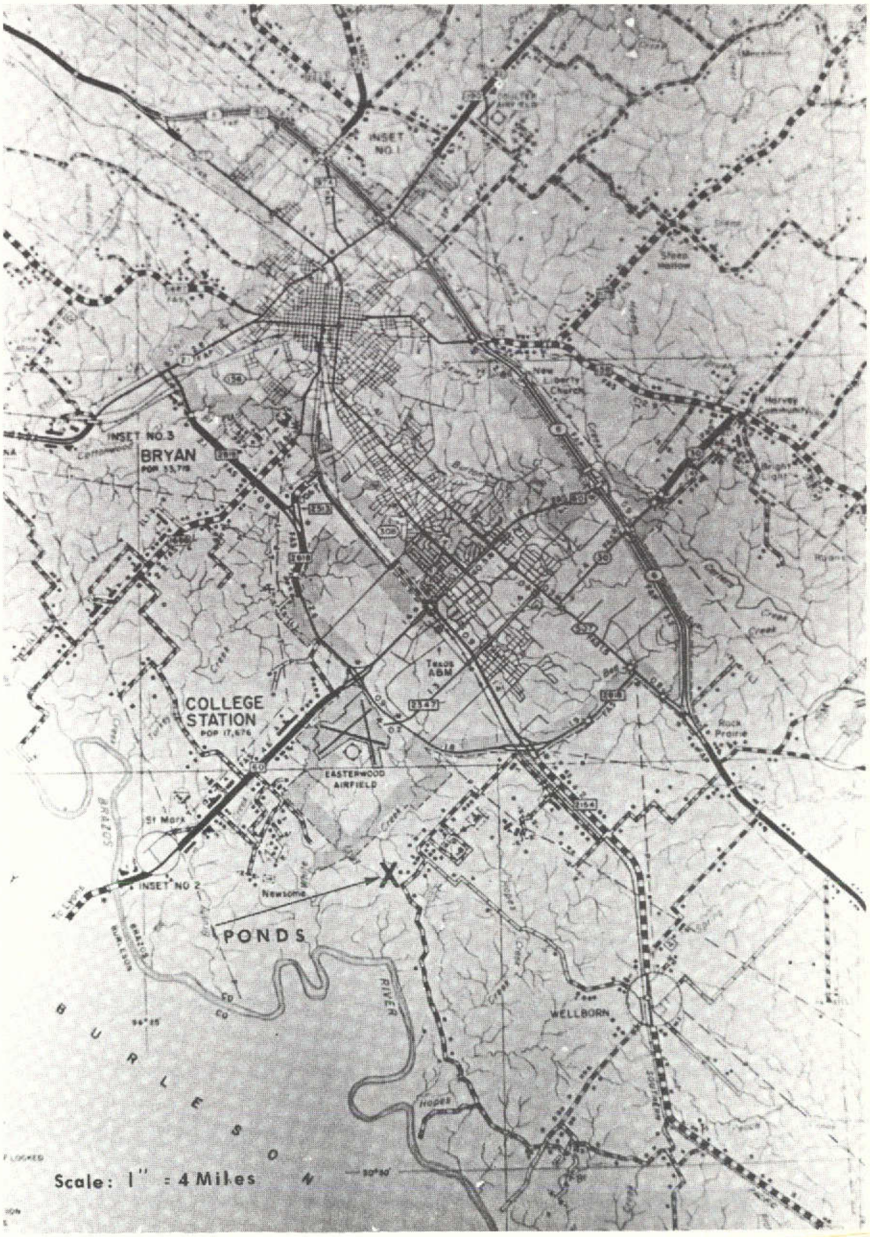


Figure 2. Excerpt from map of Brazos County, Texas.

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Figure 3. Aerial photograph showing the six study ponds.

Meyers (1973) described five of these ponds. He states that pond #1 held the smallest volume and surface area and pond #4 the largest. Table 1 contains a listing of some of the physical characteristics of these ponds. The information was compiled from work done by Meyers (1973) and Respes, et al. (1972).

Table 1. Physical Characteristics of the Sampled Ponds.

Pond #	V M^3	A M^2	Lm M	Dm M	S M
1	495	455	30	1.8	81
2	1630	1770	96	2.3	248
3	945	940	60	2.1	196
4	74604	20079	239	9.1	1341
5	14266	7352	263	4.6	893
30	15200	6700	250	3.3	965

V = volume A = area Lm = maximum length
Dm = maximum depth S = shore length

Camera System

A three camera multiband systems was designed and a mounting frame was constructed from a 1 x 1/8 inch steel bar. A multiple cable release system allowed the shutters of the three cameras to be triggered simultaneously. This sytem is shown in Figure 4. Each camera was equipped with a polarizing filter to eliminate glare caused by reflected light from the surface of the water. Four film types were employed, each having different spectral

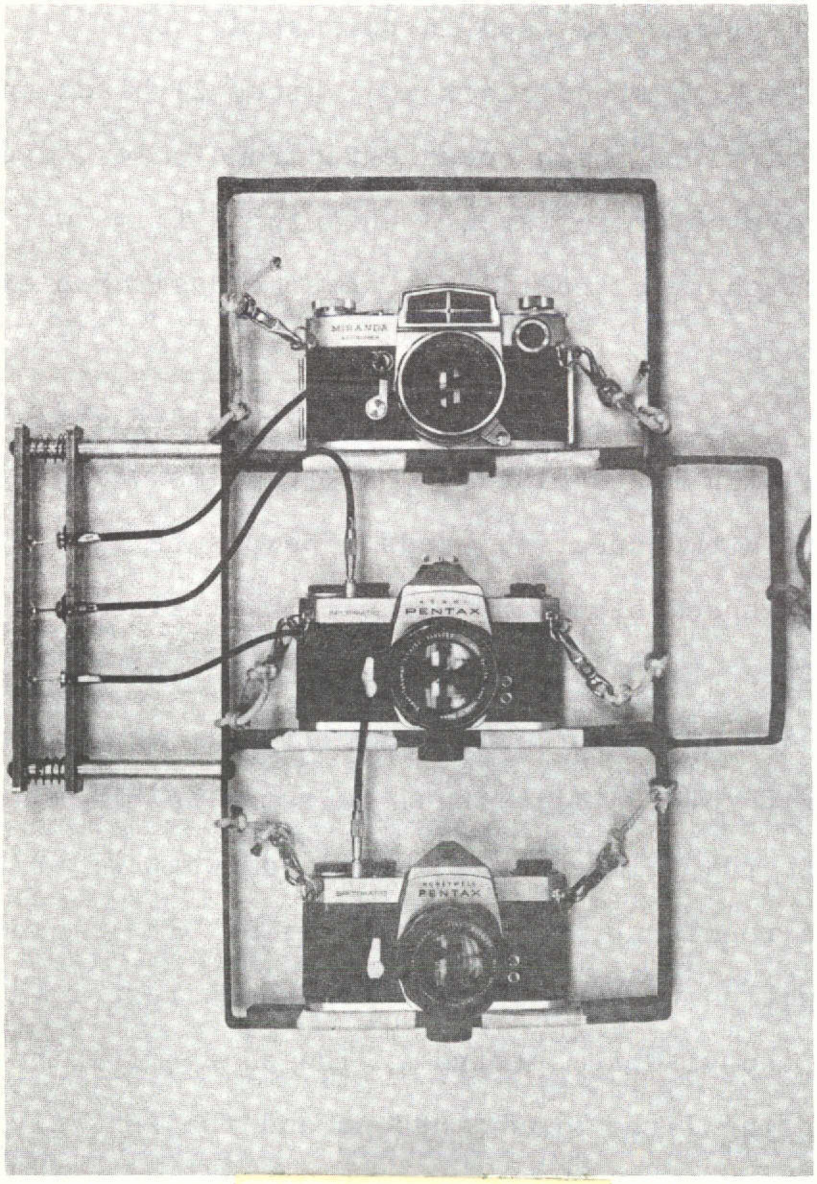


Figure 4. Multiband 35mm camera system.

sensitivities. Approximate sensitivity curves for these film types are shown in Figures 5, 6, 7, and 8. The four film types used in this study were: 1) Kodak Tri-X high speed black and white, 2) black and white infrared, 3) high speed ektachrome color, and 4) ektachrome color infrared. When these films were exposed through selected filters several desirable effects were obtained.

Chlorophyll Detection. The black and white infrared and high speed black and white films were filtered to obtain two spectral bands of exposure side by side. The high speed black and white film utilized a Wratten 92 filter which transmits light beginning at a wavelength of 630 nm. The band recorded ends at 670 nm due to the limits of the film sensitivity. The black and white infrared film records a band somewhat wider than that of the regular black and white film. It is used in conjunction with an 89 B filter which restricts nearly all of the visible spectrum. The 89 B filter begins transmitting light around 690 nm and the sensitivity limit of the film around 900 nm provides the other end of this pass band. Figures 9 and 10 show the pass bands created by these filters superimposed on the appropriate film sensitivity curve.

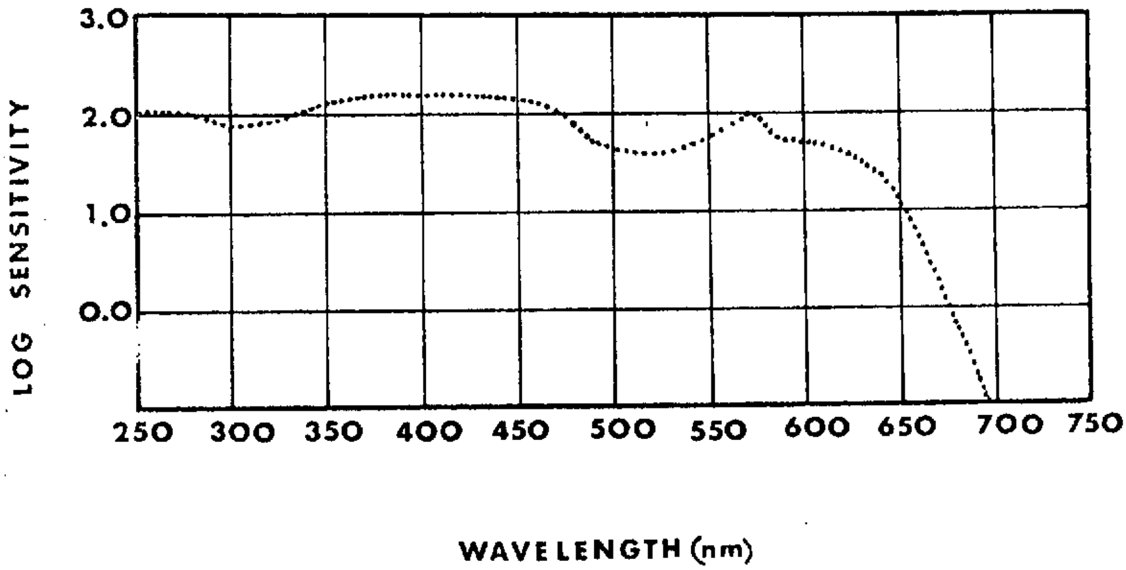


Figure 5. Sensitivity curve for Kodak Tri-X film.

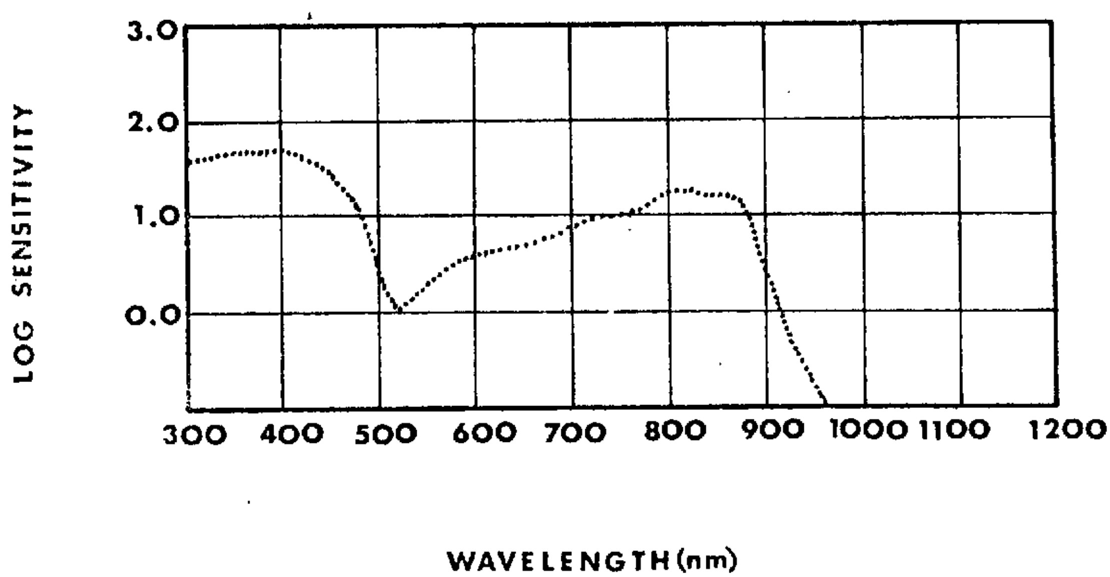


Figure 6. Sensitivity curve for Kodak high speed black and white infrared film.

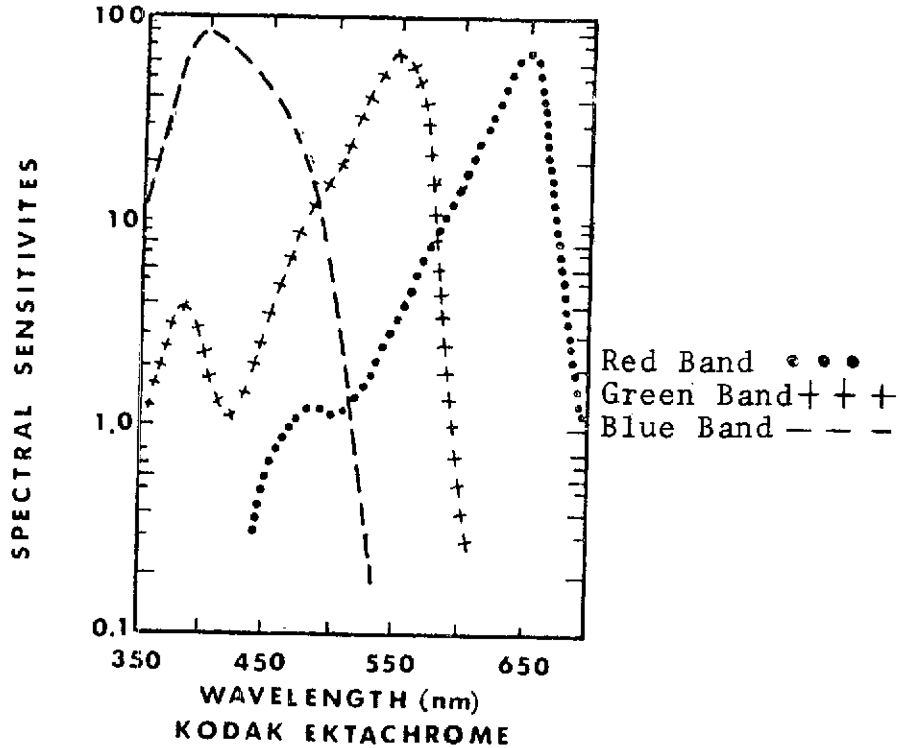


Figure 7. Sensitivity curve Kodak Ektachrome film high speed (Orr, 1968).

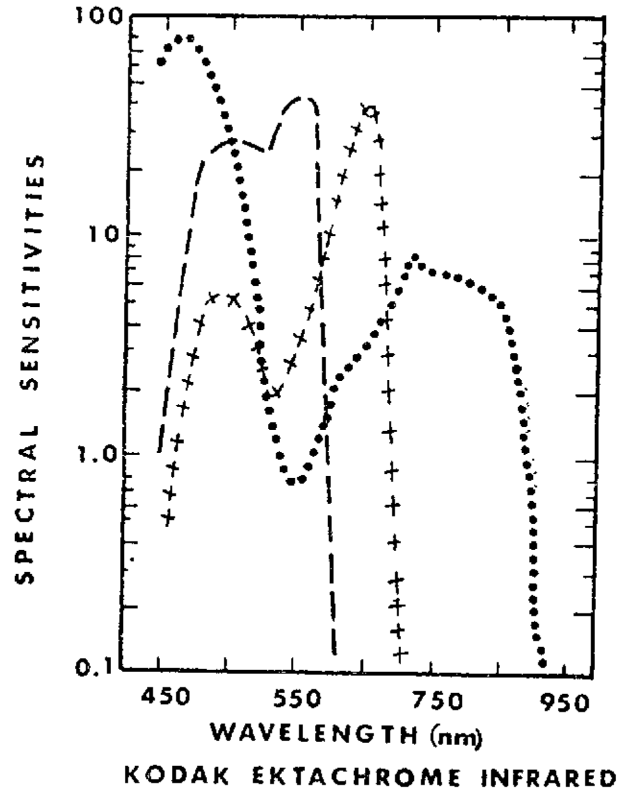


Figure 8. Sensitivity curve Kodak Ektachrome infrared film (Orr, 1968).

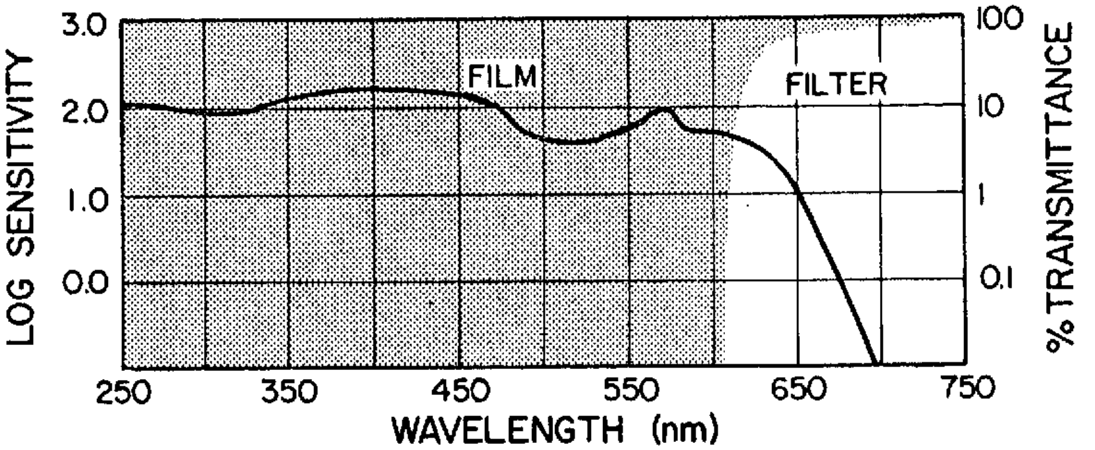


Figure 9. Pass band created by combination of Wratten 92 filter and Tri-X film.

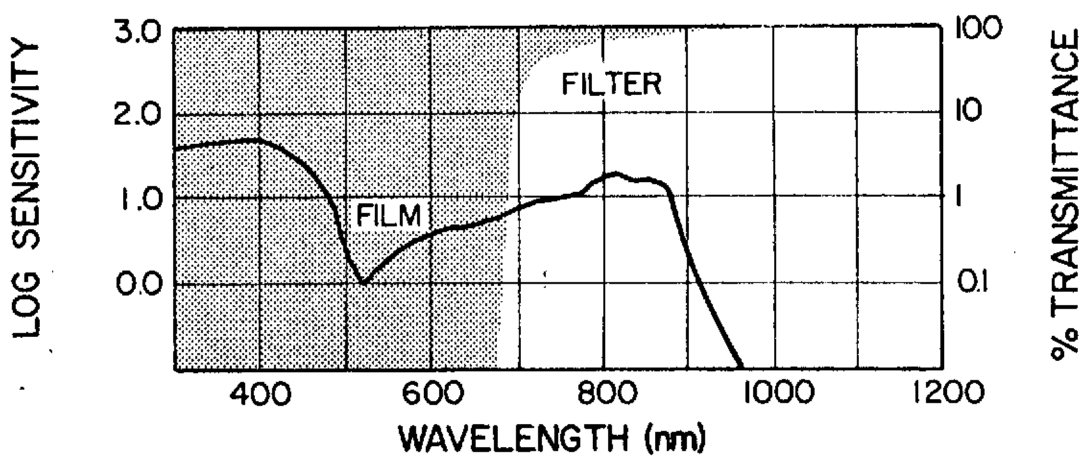


Figure 10. Pass band created by combination of Wratten 89B filter and Kodak black and white infrared film.

As was noted earlier chlorophyll has a double-peaked absorption curve. A representative curve is shown in Figure 11. One of these peaks occurs in the wavelength range of 630-670 nm. The other occurs around 420-440 nm. From the standpoint of aerial photography, the shorter wavelength band is a less desirable area to work in, due to higher atmospheric attenuation and light scatter in this band. However, of the two absorption peaks, the latter is the stronger. For this portion of the investigation, the film was changed in the two cameras containing black and white film. A roll of high speed black and white Tri-X film was loaded in each camera. The filters on these cameras were then changed. One camera was filtered with a Wratten 50 which transmits light in the blue range from 420-460 nm. The other camera was filtered with a combination of a Wratten 12 which blocks out light below 500 nm, and a Wratten 55 which puts an upper limit on this band range around 590 nm. This combination of filters on the second camera provided a reference band in the area of minimum absorption in the green band. Figures 12 and 13 show the pass bands created by these filter combinations superimposed on the appropriate film sensitivity curves.

<u>Turbidity Detection</u>. In the portion of the study involving the detection of turbidity, color and color

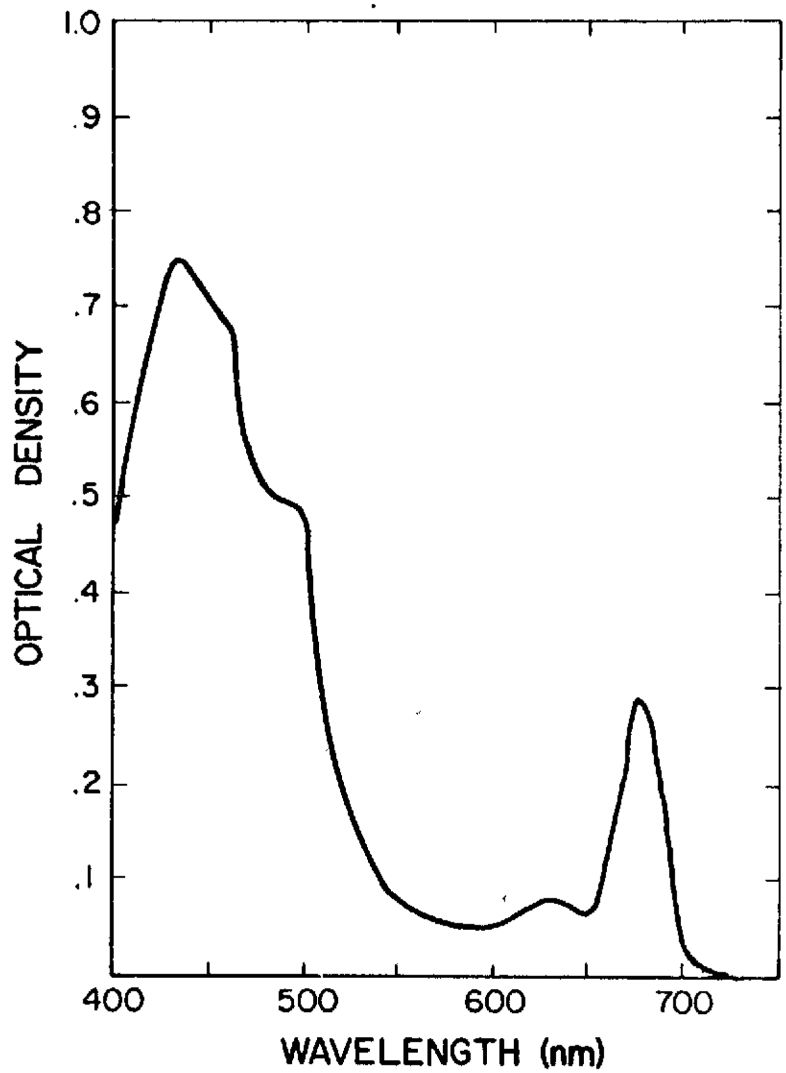


Figure 11. Representative chlorophyll absorption curve, (Yentsch, 1960).

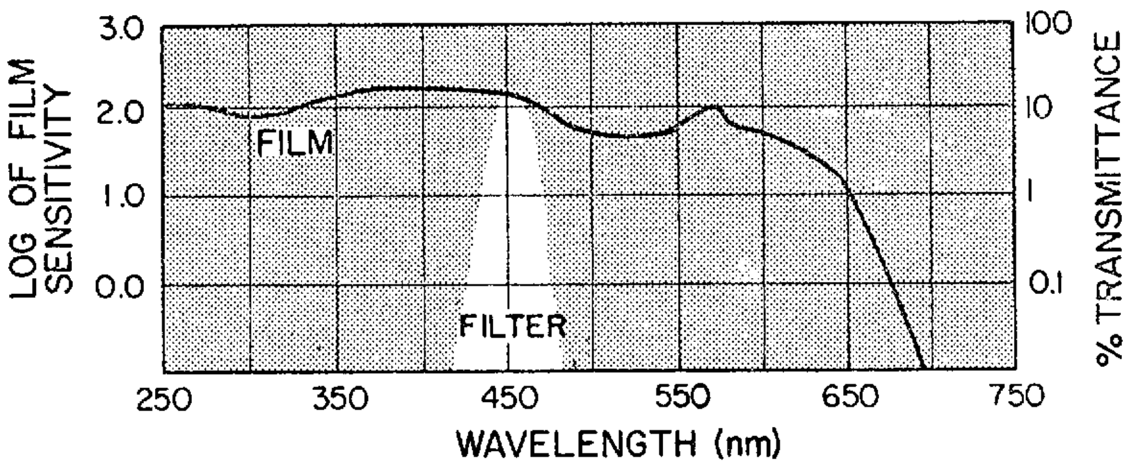


Figure 12. Pass band created by combination of Wratten 50 filter and Tri-X film.

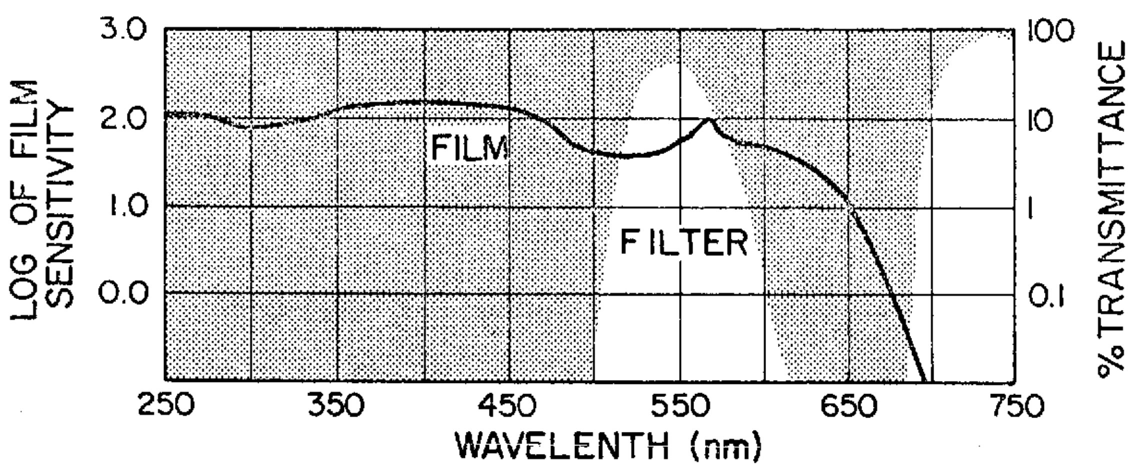


Figure 13. Pass band created by combination of Wratten 55 and 12 filters and Tri-X film.

infrared film was used. The color film was used to record the whole range of the visible spectrum with only a polarizing filter in place. The color infrared film was filtered with a Wratten 12 filter. As noted from the filter transmittance curve shown in Figure 14 this filter eliminates spectral return below 500 nm which helps to keep the effects of atmospheric scattering in this band range to a minimum.

Field Program

At the time of the aerial photography, water samples were taken at each of the six ponds for laboratory analysis of turbidity and chlorophyll. Water samples were collected from a boat whenever it was available. At other times undisturbed samples were obtained near the shore of each pond.

Triplicate samples were taken beginning July 4, 1973. Usually ground sampling and the aerial photographic missions began simultaneously. Initially the field sampling began around 11:30 a.m. - 12:00 Noon CDT. In June and July cloud cover developed near noon and the time constraints were broadened to include the hours between 10:00 a.m. and 4:00 p.m. CDT. This permitted flights before cloud cover developed and at times after it had dissipated. At times flights were made with partial cloud

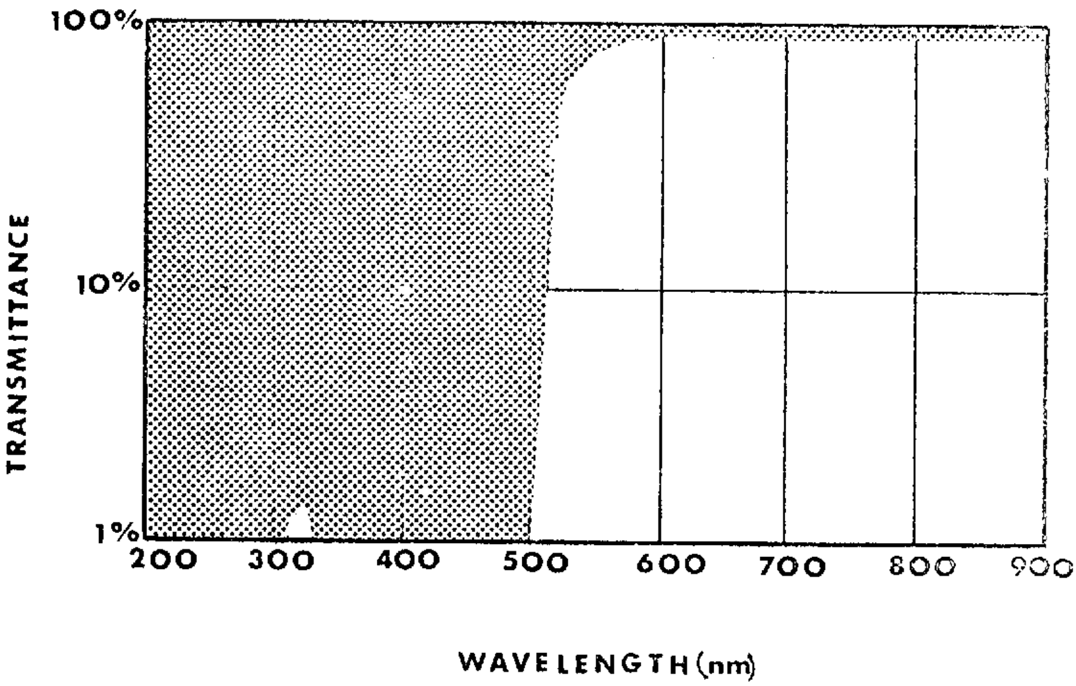


Figure 14. Transmittance curve for Wratten 12 filter.

cover and once with a uniform haze condition. When partly cloudy conditions prevailed, care was taken to avoid shadows over the ponds and cloud reflections from the surface when taking the photographs. The aerial photography missions were flown at an altitude of 500 feet. Each roll of film used was standardized on the ground with a photograph of a standard 18 percent reflectance gray card, taken outdoors with the same relative sun angle used in photographing the ponds. The aerial photography missions were flown by the Texas Engineering Experiment Station flight laboratory personnel. The aircraft was a single-engine Beaver with the left door removed, to provide the photographer with an unobstructed view of the ponds. The photography and subsequent processing of the film was provided by the aerial photography technician of the Texas A&M Remote Sensing Center, environmental monitoring laboratory. Photographic exposure and a summary of the weather data are given in Appendix A.

Laboratory Analysis

The samples of water collected from each of the ponds during the overflights were returned to the campus for analysis. Turbidity measurements were made with a Hach model 1860 A turbidimeter. Chlorophyll measurements were made by the acetone extraction method of Strickland

and Parsons (1960). The samples were read after a 24 hour extraction period under dark refrigerated conditions. Optical density readings were taken on a Beckmann DBG spectrophotometer, at two wavelengths, 665 nm and 750 nm. The latter is a turbidity correction factor. The calculations used were based on those derived by Talling and Driver (1963) as an approximation to Parsons and Strickland's (1963) refinement of their earlier trichromatic equation. The following equation calculates chlorophyll $\underline{a}$ in Mg/M^3:

$$CHL = 11.9\ D_{665}\ Va/(V_w L)$$

CHL = Mg of chlorophyll -$\underline{a}$ per cubic meter

11.9 = specific absorption constant

D_{665} = optical density at 665 nm minus turbidity correction at 750 nm.

Va = volume of (acetone) extract in ml.

L = length of light path in spectrophotometer in cm.

V_w = volume of water filtered in liters

The data obtained from this analysis appear in Appendix B.

The film was processed at the Environmental Engineering Division's dark room in the Texas A&M University Civil Engineering Building. New chemicals were mixed for each roll of film processed. The color film was processed using a Kodak E-4 kit. The black and white infrared film

was processed with Kodak D-19 developer for 8 minutes at 68°F. The black and white panchromatic film was also processed with D-19 developer. The film was then examined with a Macbeth TD 504 photodensitometer. Readings were taken with the visible setting of the instrument for the black and white films and with the three color settings of the instrument for the color films. Replicate point and transect readings were taken on selected dates. The latter readings were at right angles to the flight path. The densitometer readings are listed in Appendix C.

Data Analysis

Light values were calculated from film density values and compared to the field turbidity and chlorophyll data. A stepwise regression was performed to obtain the best correlation between photographic values and field data. Analysis of variance was performed on replicate densitometer readings, taken at the same points on the photograph. A nested classification was used for the replicate densitometer readings (Johnson and Leone, 1964). Transect readings were also taken to show variability of film density across the photograph.

RESULTS AND DISCUSSION

Turbidity

It was found that the best procedure for measuring turbidity from aerial photography was to utilize density readings from two film types, dividing the turbidity values into two ranges. The red band of color infrared film was used for turbidity measurement above 35 JTU. The equation that finally established the best relationship was a comparison of turbidity and the exponential of the difference between the density reading in this band and the gray card density in the red band. The following equation was used to relate film density to turbidity values greater than 35 JTU:

$$Tur_1 = B_o + B_1 \text{ Exp (SRI-RI)}.$$

Tur_1 = Turbidity greater than 35 JTU.

Exp (SRI-RI) = e (Standard Mathematical constant approximately equal to 2.73) raised to the (SRI-RI) power.

SRI-RI = The density reading taken in the red band of the color infrared film subtracted from the red band reading taken from the gray card standardization frame.

B_o and B_1 = Constants derived by linear least square analysis.

A similar linear relationship was established for the low range of turbidity readings from 0-35 JTU. However, the best equation for this range utilized the density readings in the green band of regular ektachrome film and the green band gray card density. The equation used for this range is explained below:

$Tur_2 = B_o + B_1$ (SGC-GC).

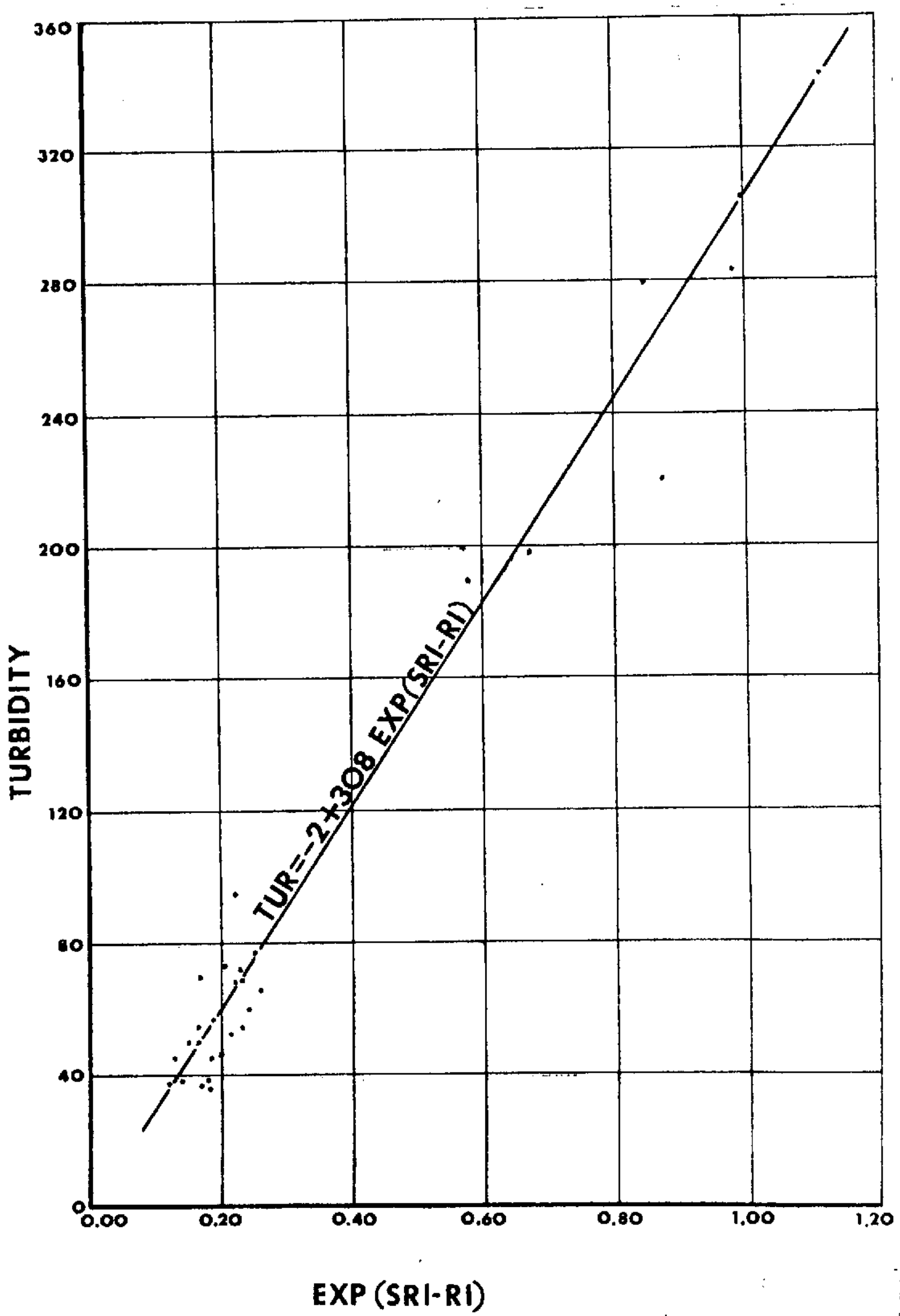
Tur_2 = Turbidity less than 35 JTU.

SGC-GC = Density reading taken in the green band on normal color film minus the gray card density reading in the green band of this film type.

B_o and B_1 = Constants determined a linear least square regression analysis.

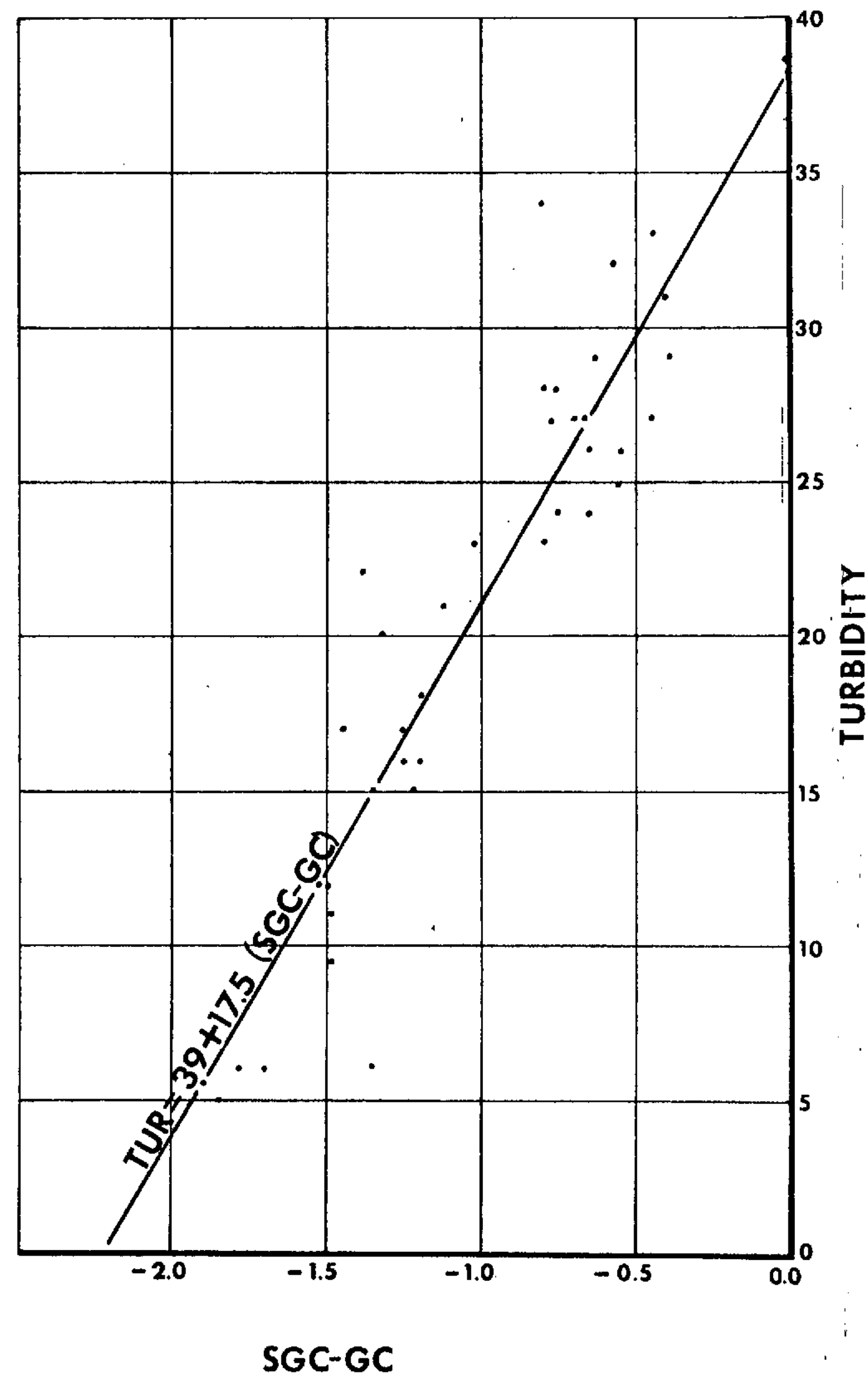
In each case a variety of relationships were proposed and applied to the data. These two equations provided the best correlation. A stepwise regression analysis was utilized to determine the correlation coefficients relating the proposed equations for film density and turbidity. It was found that the high range of turbidity (35-342 JTU) had a correlation coefficient of (0.975) when compared with the model involving the exponential of the ratio between the red band color infrared and the red band of the gray card correction on the color infrared film. The low range had a correlation coefficient of 0.922, slightly lower than the high range. Figures 15 and 16 show how these points plot along with the calculated regression

Figure 15. Plot of the high range of turbidities (>35 JTU) and the exponential of the color infrared red band reading minus the gray card reading.



360
320
280
240
200
160
120
80
40
0
TURBIDITY
0.00
0.20
0.40
0.60
0.80
1.00
1.20
EXP (SRI-RI)
TUR=-2+308 EXP(SRI-RI)

Figure 16. Plot of the low range of turbidities (<35 JTU) and the color green band reading minus the gray card correction.



TUR = 39+17.5 (SGC-GC)
40
35
30
25
20
15
10
5
0
TURBIDITY
-2.0
-1.5
-1.0
-0.5
0.0
SGC-GC

lines.

Five days were selected and triplicate readings were taken at each of three points in the six ponds. The readings were taken in the red band on color infrared film and in the green band on the normal color film. The mean and standard deviation of the three observations and the standard deviation of the mean were calculated. The data derived from this test are shown in Tables 2 and 3.

The analysis of variance table for the data listed in Tables 2 and 3 is given in Table 4. The analysis was conducted for a nested classification of six ponds and three points within each pond. The test was designed to determine if there is a significant difference in film density readings between ponds, and to determine if the film density readings vary significantly from point to point within the pond.

The reproducibility of measurements at each point within ponds is indicated by the mean square residual at the points. These values ranged from -0.00019 to 0.0019 within the ponds. This indicates that maximum variation from the observed values would be 0.087 at the 95% confidence level.

The hypothesis that there is not any difference in the film density readings between the various ponds was tested.

Table 2. Density Variation Between and Within Ponds for Color Infrared Film, Red Band (page 1 of 5).

POND		1			2			3		
POINT		1	2	3	1	2	3	1	2	3
	1)	1.590	1.620	1.600	3.050	3.090	3.070	3.350	3.360	3.360
5/28/73	2)	1.610	1.630	1.630	3.070	3.100	3.150	3.320	3.390	3.340
	3)	1.620	1.630	1.600	3.050	3.100	3.110	3.370	3.390	3.340
MEAN		1.610	1.630	1.610	3.050	3.100	3.110	3.350	3.380	3.350
S.D.O.		0.020	0.010	0.020	0.020	0.006	0.040	0.030	0.017	0.011
S.D.M.		0.010	0.005	0.010	0.010	0.003	0.020	0.015	0.010	0.007

Replication

POND		4			5			30		
POINT		1	2	3	1	2	3	1	2	3
	1)	3.320	3.300	3.260	3.370	3.370	3.390	2.970	2.740	3.850
5/28/73	2)	3.360	3.330	3.250	3.400	3.390	3.390	2.960	2.730	2.820
	3)	3.360	3.310	3.270	3.410	3.400	3.390	2.950	2.720	3.850
MEAN		3.350	3.310	3.260	3.390	3.390	3.390	2.960	2.730	2.840
S.D.O.		0.023	0.015	0.010	0.020	0.015	0.000	0.010	0.010	0.017
S.D.M.		0.013	0.009	0.006	0.012	0.009	0.000	0.006	0.006	0.010

S.D.O. = Standard Deviation of the Observation
S.D.M. = Standard Deviation of the Mean

Table 2. (page 2 of 5)

Replication

POND		1			2			3		
POINT		1	2	3	1	2	3	1	2	3
	1)	1.900	1.890	1.940	3.020	3.050	3.100	3.250	3.260	3.280
5/30/73	2)	1.890	1.920	1.920	3.050	3.120	3.100	3.290	3.300	3.280
	3)	1.900	1.920	1.930	3.070	3.110	3.120	3.310	3.300	3.300
MEAN		1.900	1.910	1.930	3.050	3.090	3.110	3.280	3.290	3.290
S.D.O.		0.006	0.010	0.010	0.025	0.037	0.012	0.030	0.023	0.010
S.D.M.		0.003	0.006	0.006	0.015	0.021	0.007	0.017	0.013	0.006

POND		4			5			30		
POINT		1	2	3	1	2	3	1	2	3
	1)	3.220	3.230	3.240	3.280	3.280	3.310	2.950	2.940	2.930
5/30/73	2)	3.290	3.280	3.240	3.320	3.300	3.310	2.980	3.020	2.770
	3)	3.280	3.270	3.240	3.320	3.330	3.330	2.990	3.020	2.780
MEAN		3.260	3.260	3.240	3.310	3.300	3.320	2.970	2.990	2.830
S.D.O.		0.037	0.026	0.000	0.023	0.025	0.012	0.020	0.046	0.090
S.D.M.		0.021	0.015	0.000	0.013	0.015	0.070	0.012	0.027	0.052

S.D.O. = Standard Deviation of the Observation
S.D.M. = Standard Deviation of the Mean

Table 2. (page 3 of 5)

POND		1			2			3		
POINT		1	2	3	1	2	3	1	2	3
	1)	1.580	1.570	1.580	3.010	3.010	2.910	3.260	3.260	2.950
6/6/73	2)	1.570	1.580	1.590	2.950	3.000	2.920	3.270	3.270	2.950
	3)	1.580	1.580	1.600	2.940	3.000	2.910	3.270	3.270	2.940
MEAN		1.580	1.580	1.590	2.970	3.000	2.910	3.270	3.270	2.950
S.D.O.		0.005	0.005	0.010	0.037	0.005	0.005	0.005	0.005	0.005
S.D.M.		0.003	0.003	0.006	0.022	0.003	0.003	0.003	0.003	0.003

Replications

POND		4			5			30		
POINT		1	2	3	1	2	3	1	2	3
	1)	3.190	3.260	3.160	3.320	3.320	3.310	2.490	2.480	2.450
6/6/73	2)	3.200	3.150	3.140	3.310	3.330	3.320	2.440	2.520	2.450
	3)	3.190	3.150	3.130	3.330	3.330	3.250	2.510	2.530	2.440
MEAN		3.190	3.190	3.140	3.320	3.330	3.290	2.480	2.510	2.450
S.D.O.		0.005	0.064	0.015	0.010	0.005	0.037	0.036	0.027	0.005
S.D.M.		0.003	0.037	0.009	0.006	0.003	0.021	0.021	0.015	0.003

S.D.O. = Standard Deviation of the Observation
S.D.M. = Standard Deviation of the Mean

Table 2. (page 4 of 5)

Replication

POND		1			2			3		
POINT		1	2	3	1	2	3	1	2	3
	1)	1.320	1.340	1.330	2.900	2.940	2.950	3.190	3.200	3.220
6/26/73	2)	1.340	1.380	1.340	2.990	3.000	2.860	3.190	3.230	3.220
	3)	1.330	1.380	1.350	2.990	2.990	2.870	3.190	3.220	3.210
MEAN		1.330	1.360	1.340	2.960	2.980	2.890	3.190	3.220	3.220
S.D.O.		0.010	0.013	0.010	0.520	0.032	0.490	0.000	0.015	0.005
S.D.M.		0.006	0.008	0.006	0.030	0.019	0.028	0.000	0.009	0.003

POND		4			5			30		
POINT		1	2	3	1	2	3	1	2	3
	1)	3.250	3.250	3.200	3.250	3.340	3.360	2.960	2.900	2.850
6/26/73	2)	3.180	3.250	3.260	3.330	3.340	3.330	2.990	2.940	2.840
	3)	3.160	3.150	3.250	3.330	3.350	3.320	2.990	2.950	2.840
MEAN		3.200	3.220	3.240	3.300	3.340	3.340	2.980	2.930	2.840
S.D.O.		0.047	0.057	0.032	0.046	0.055	0.021	0.017	0.027	0.005
S.D.M.		0.027	0.033	0.019	0.027	0.003	0.012	0.010	0.015	0.003

S.D.O. = Standard Deviation of the Observation
S.D.M. = Standard Deviation of the Mean

Table 2. (page 5 of 5)

POND		1			2			3		
POINT		1	2	3	1	2	3	1	2	3
7/4/73	1)	0.580	0.570	0.570	2.260	2.310	2.260	2.960	2.980	3.000
	2)	0.590	0.580	0.580	2.290	2.330	2.350	2.970	2.990	2.980
	3)	0.580	0.580	0.580	2.300	2.350	2.340	2.960	2.980	2.990
MEAN		0.580	0.580	0.580	2.280	2.330	2.320	2.970	2.980	2.990
S.D.O.		0.005	0.005	0.005	0.021	0.020	0.049	0.005	0.005	0.010
S.D.M.		0.003	0.003	0.003	0.012	0.012	0.029	0.003	0.003	0.006

Replication

POND		4			5			30		
POINT		1	2	3	1	2	3	1	2	3
7/4/73	1)	2.850	3.000	2.870	3.330	3.320	3.330	2.140	2.370	2.420
	2)	2.850	2.980	2.860	3.320	3.310	3.320	2.110	2.400	2.360
	3)	2.840	2.990	2.890	3.320	3.310	3.320	2.130	2.380	2.390
MEAN		2.850	2.990	2.870	3.320	3.310	3.320	2.130	2.380	2.390
S.D.O.		0.005	0.010	0.015	0.005	0.005	0.005	0.015	0.012	0.030
S.D.M.		0.003	0.006	0.009	0.003	0.003	0.003	0.009	0.007	0.017

S.D.O. = Standard Deviation of the Observation
S.D.M. = Standard Deviation of the Mean

Table 3. Density Variations Between and Within Ponds for Color Film, Green Band

POND	Replications	1			2			3		
POINT		1	2	3	1	2	3	1	2	3
	1)	0.500	0.520	0.540	0.670	0.750	0.700	1.580	1.630	1.670
5/28/73	2)	0.500	0.530	0.530	0.700	0.750	0.780	1.590	1.640	1.680
	3)	0.500	0.520	0.530	0.660	0.750	0.770	1.580	1.640	1.690
MEAN		0.500	0.520	0.530	0.680	0.750	0.750	1.580	1.640	1.680
S.D.O.		0.000	0.005	0.005	0.021	0.000	0.044	0.005	0.005	0.010
S.D.M.		0.000	0.003	0.003	0.012	0.000	0.025	0.003	0.003	0.006

POND	Replications	4			5			30		
POINT		1	2	3	1	2	3	1	2	3
	1)	1.270	1.110	1.110	1.940	1.810	1.780	0.600	0.560	0.530
5/28/73	2)	1.170	1.060	1.100	1.910	1.860	1.770	0.600	0.560	0.520
	3)	1.150	1.070	1.120	1.900	1.830	1.760	0.640	0.560	0.520
MEAN		1.190	1.080	1.110	1.920	1.830	1.770	0.610	0.560	0.520
S.D.O.		0.640	0.270	0.010	0.021	0.025	0.010	0.023	0.000	0.005
S.D.M.		0.037	0.015	0.006	0.012	0.015	0.006	0.013	0.000	0.003

S.D.O. = Standard Deviation of the Observation
S.D.M. = Standard Deviation of the Mean

Table 3. (page 2 of 5)

Replications

POND		1			2			3		
POINT		1	2	3	1	2	3	1	2	3
5/30/73	1)	0.580	0.560	0.590	0.850	0.870	0.880	1.750	1.780	1.760
	2)	0.530	0.570	0.560	0.840	0.850	0.860	1.740	1.770	1.750
	3)	0.520	0.520	0.530	0.840	0.850	0.850	1.740	1.760	1.770
MEAN		0.540	0.550	0.560	0.840	0.860	0.860	1.740	0.770	0.760
S.D.O.		0.032	0.270	0.030	0.005	0.012	0.010	0.005	0.010	0.010
S.D.M.		0.019	0.015	0.017	0.003	0.007	0.006	0.003	0.006	0.006

POND		4			5			30		
POINT		1	2	3	1	2	3	1	2	3
5/30/73	1)	1.130	1.110	1.090	1.920	1.940	2.050	0.660	0.640	0.580
	2)	1.110	1.090	0.060	1.910	1.920	2.000	0.650	0.610	0.580
	3)	1.100	1.090	1.060	1.920	1.930	2.010	0.650	0.640	0.570
MEAN		1.110	1.100	1.070	1.920	1.930	2.020	0.650	0.630	0.580
S.D.O.		0.015	0.012	0.017	0.005	0.010	0.027	0.005	0.017	0.005
S.D.M.		0.009	0.007	0.010	0.003	0.006	0.015	0.003	0.010	0.003

S.D.O. = Standard Deviation of the Observation
S.D.M. = Standard Deviation of the Mean

Replications

Table 3. (page 3 of 5)

POND		1			2			3		
POINT		1	2	3	1	2	3	1	2	3
	1)	0.760	0.730	0.760	1.140	1.160	1.150	1.800	1.840	1.820
6/6/73	2)	0.710	0.740	0.730	1.140	1.160	1.150	1.830	1.850	1.840
	3)	0.700	0.720	0.740	1.130	1.150	1.140	1.830	1.840	1.820
MEAN		0.720	0.730	0.740	1.140	1.160	1.150	1.820	1.840	1.830
S.D.O.		0.032	0.010	0.015	0.005	0.005	0.005	0.017	0.005	0.012
S.D.M.		0.019	0.006	0.009	0.003	0.003	0.003	0.010	0.003	0.007

POND		4			5			30		
POINT		1	2	3	1	2	3	1	2	3
	1)	1.530	1.440	1.410	2.120	2.150	2.070	0.820	0.760	0.730
6/6/73	2)	1.540	1.410	1.390	2.120	2.130	2.050	0.800	0.760	0.730
	3)	1.530	1.400	1.370	2.110	2.120	2.050	0.810	0.760	0.720
MEAN		1.530	1.420	1.390	2.120	2.130	2.060	0.810	0.760	0.730
		0.005	0.210	0.200	0.005	0.015	0.012	0.010	0.000	0.005
		0.003	0.012	0.012	0.003	0.009	0.007	0.006	0.000	0.003

S.D.O. = Standard Deviation of the Observation
S.D.M. = Standard Deviation of the Mean

Table 3. (page 4 of 5)

Replications

POND		1			2			3		
POINT		1	2	3	1	2	3	1	2	3
6/26/73	1)	0.870	0.880	0.890	1.280	1.290	1.310	1.850	1.920	1.920
	2)	0.870	0.880	0.880	1.280	1.290	1.300	1.850	1.920	1.920
	3)	0.870	0.880	0.890	1.260	1.280	1.290	1.840	1.890	1.910
MEAN		1.870	0.870	0.890	1.270	1.290	1.300	1.850	1.910	1.920
S.D.O.		0.000	0.000	0.005	0.012	0.005	0.010	0.005	0.017	0.005
S.D.M.		0.000	0.000	0.003	0.007	0.003	0.006	0.003	0.010	0.003

POND		4			5			30		
POINT		1	2	3	1	2	3	1	2	3
6/26/73	1)	1.660	1.650	1.470	2.430	2.400	2.570	1.340	1.270	1.180
	2)	1.690	1.640	1.560	2.430	2.420	2.580	1.320	1.270	1.130
	3)	1.690	1.660	1.530	2.410	2.400	2.540	1.310	1.280	1.130
MEANS		1.680	1.650	1.520	2.420	2.410	2.560	1.320	1.270	1.150
S.D.O.		0.170	0.010	0.460	0.120	0.120	0.210	0.015	0.005	0.290
S.D.M.		0.010	0.006	0.270	0.007	0.007	0.012	0.009	0.003	0.017

S.D.O. = Standard Deviation of the Observation
S.D.M. = Standard Deviation of the Mean

Table 3. (page 5 of 5)

Replications

POND		1			2			3		
POINT		1	2	3	1	2	3	1	2	3
	1)	0.440	0.440	0.440	0.920	0.930	0.950	1.700	1.750	1.740
7/4/73	2)	0.430	0.430	0.430	0.910	0.910	0.940	1.710	1.740	1.730
	3)	0.420	0.430	0.430	0.900	0.910	0.930	1.680	1.710	1.740
MEAN		0.430	0.430	0.430	0.910	0.920	0.940	1.700	1.730	1.740
S.D.O.		0.005	0.000	0.000	0.010	0.012	0.010	0.150	0.021	0.005
S.D.M.		0.003	0.000	0.000	0.006	0.007	0.006	0.009	0.012	0.003

POND		4			5			30		
POINT		1	2	3	1	2	3	1	2	3
	1)	1.130	1.100	1.120	2.130	2.140	2.210	0.800	0.780	0.780
7/4/73	2)	1.120	1.090	1.140	2.120	2.130	2.200	0.780	0.760	0.760
	3)	1.090	1.100	1.090	2.140	2.120	2.220	0.780	0.760	0.750
MEAN		1.110	1.100	1.120	2.130	2.130	2.210	0.790	0.770	0.760
S.D.O.		0.021	0.005	0.025	0.010	0.010	0.010	0.012	0.012	0.015
S.D.M.		0.012	0.003	0.015	0.006	0.006	0.006	0.007	0.007	0.009

S.D.O. = Standard Deviation of the Observation
S.D.M. = Standard Deviation of the Mean

Table 4. Analysis of Variance for Film Density Readings Between and Within Ponds

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	CALCULATED F-VALUE
	5-28-73 Color IR - Red Band			
Pond	20.6633	5	4.13000	513
Location	0.0967	12	0.00800	7.3
Repetitions	0.0400	36	0.00110	
Total	20.1999	53	0.39240	
	5-28-73 Normal Color - Green Band			
Pond	14.3250	5	2.86500	368
Location	0.0930	12	0.00780	4.1
Repetitions	0.0100	36	0.00190	
Total	14.4280	53	0.40070	
	5-30-73 Color IR - Red Band			
Pond	12.8510	5	2.57000	524
Location	0.0590	12	0.00490	5.4
Repetition	0.0330	36	0.00090	
Total	12.9430	53	0.24420	
	5-30-73 Normal Color - Green Band			
Pond	15.7280	5	3.14580	1165
Location	0.0322	12	0.00270	14.2
Repetition	0.0066	36	0.00019	
Total	15.7669	53	0.11474	
	6-6-73 Color IR - Red Band			
Pond	19.3067	5	3.86130	202
Location	0.2289	12	0.01910	41.5
Repetition	0.0166	36	0.00050	
Total	19.5522	54	0.36210	
	6-6-73 Normal Color - Green Band			
Pond	14.1140	5	2.82230	588
Location	0.0578	12	0.00480	8.0
Repetition	0.0200	36	0.00060	
Total	14.1918	53	0.26770	

Table 4. (Continued)

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	CALCULATED F-VALUE
	6-26-73 Color IR - Red Band			
Pond	24.8760	5	4.97500	1250
Location	0.0478	12	0.00400	3.6
Repetitions	0.0400	36	0.00110	
Total	24.9637	54	0.46230	
	6-26-73 Normal Color - Green Band			
Pond	14.1010	5	2.82030	227
Location	0.1490	12	0.01240	65.3
Repetitions	0.0070	36	0.00019	
Total	14.2560	53	0.26900	
	7-4-73 Color IR - Red Band			
Pond	42.9240	5	8.58500	584
Location	0.1767	12	0.01470	39.7
Repetition	0.0133	36	0.00037	
Total	43.1140	53	0.85120	
	7-4-73 Normal Color - Green Band			
Pond	18.4010	5	3.68030	2344
Location	0.0189	12	0.00157	8.3
Repetition	0.0067	36	0.00019	
Total	18.4270	53	0.34770	

The F statistic was used for this test and was determined by dividing the mean square residual between ponds (5 d.f.) by the mean square residual within ponds (12 d.f.). The critical range for this test at 95% significance level is $F > 3.11$. As listed in Table 4 the computed values of this statistic are all in the critical range and were 513, 368, 524, 1165, 202, 588, 1250, 227, 584, and 2344. The hypothesis is rejected and the conclusion from this test is that there is a significant difference in film density readings between the ponds.

A second hypothesis that there is not any significant difference in film density values from point to point within the ponds was also tested on these same data. The differences in density readings between days were not included in the experiment and the hypothesis was tested separately for each of the five days. The F statistic was computed by dividing the mean square residual within each pond (12 d.f.) by the mean square residual at each point within the ponds (36 d.f.). The critical region for the test is $F > 2.04$ for a 95% significance level. The F values computed for this test were all within the critical range. It is concluded that <u>there</u> <u>is</u> a significant difference in film density values within the ponds. However, as noted in Table 4 these F values are considerably smaller than those for the differences between ponds. The analysis

of variance takes care of the variations within ponds when assessing significance between ponds. Several recommendations aimed at overcoming these differences are discussed in the next section of this paper.

In order to further verify these findings a series of transect density readings were taken for each of the three largest ponds for the five selected days. Table 5 tabulates the triplicate readings taken at each of the five points along the transects. The pond transects are shown in Figures 17, 18, 19, 20, and 21. Readings were taken in the red band, color infrared and green band, normal color. Table 6 shows a summary of the analysis of variance conducted on the data listed in Table 5. The hypothesis that there is no difference from point to point can be tested by constructing an F-test utilizing the mean square residual between points and the mean square residual at the points. The critical range for this test at the 95% level is > 3.48 (4 and 10 d.f.). It was found that pond 5 was not significant at this level in the color infrared red band on each of the five days. In other words, the variations along the transects were small and the F values for this group were less than the critical figure of 3.48. Pond 5 values probably resulted from the clarity of the pond which reduces light return in this band. Pond 4, was not significant in the red color infrared band

Table 5. Densitometer Readings Along Transects.

7-4-73 Color IR - Red Band

		Pond 4				Pond 5				Pond 30			
Replications		1	2	3	Total	1	2	3	Total	1	2	3	Total
Point	1	2.78	2.80	2.79	8.37	3.33	3.32	3.33	9.98	2.41	2.42	2.43	7.26
	2	2.81	2.81	2.82	8.44	3.32	3.33	3.33	9.98	2.39	2.39	2.39	7.17
	3	2.85	2.85	2.87	8.57	3.32	3.33	3.33	9.98	2.27	2.26	2.25	6.78
	4	2.91	2.89	2.89	8.69	3.32	3.32	3.33	9.97	2.15	2.10	2.11	6.36
	5	2.94	2.94	2.94	8.82	3.32	3.33	3.33	9.98	2.06	2.07	2.06	6.19
	G				122.6368				165.9341				75.9825
	T				122.6813				165.9342				76.2835
	Y				122.6821				165.9345				76.2854

7-4-73 Normal Color - Green Band

		Pond 4				Pond 5				Pond 30			
Replications		1	2	3	Total	1	2	3	Total	1	2	3	Total
Point	1	1.19	1.16	1.14	3.49	2.26	2.26	2.24	6.76	0.79	0.79	0.79	2.37
	2	1.14	1.12	1.10	3.36	2.21	2.24	2.21	6.66	0.78	0.77	0.77	2.33
	3	1.10	1.09	1.08	3.27	2.17	2.17	2.19	6.54	0.77	0.77	0.77	2.31
	4	1.07	1.07	1.07	3.21	2.14	2.15	2.15	6.44	0.76	0.77	0.75	2.28
	5	1.08	1.06	1.07	3.21	2.12	2.12	2.13	6.38	0.76	0.76	0.75	2.27
	G				18.2381				71.6352				8.9089
	T				18.2569				71.6676				8.9111
	Y				18.2594				71.6688				8.9114

Table 5. (page 2 of 5)

7-5-73 Color IR - Red Band

Replications	Pond 4				Pond 5				Pond 30			
	1	2	3	Total	1	2	3	Total	1	2	3	Total
Point 1	3.17	3.18	3.17	9.53	3.34	3.36	3.35	10.05	2.82	2.84	2.79	8.45
Point 2	3.17	3.19	3.19	9.55	3.35	3.36	3.35	10.06	2.81	2.71	2.73	8.25
Point 3	3.20	3.20	3.20	9.60	3.35	3.36	3.35	10.06	2.81	2.81	2.83	8.45
Point 4	3.20	3.21	3.21	9.62	3.35	3.36	3.35	10.06	2.84	2.84	2.88	8.56
Point 5	3.21	3.22	3.22	9.65	3.36	3.37	3.36	10.09	2.80	2.80	2.83	8.43
G				153.2802				168.8068				118.3853
T				153.2834				168.8071				118.4020
Y				153.2839				168.8076				118.4108

7-5-73 Normal Color - Green Band

Replications	Pond 4				Pond 5				Pond 30			
	1	2	3	Total	1	2	3	Total	1	2	3	Total
Point 1	1.27	1.26	1.27	3.80	2.11	2.12	2.10	6.33	0.83	0.82	0.82	2.47
Point 2	1.27	1.23	1.25	3.73	2.09	2.10	2.09	6.28	0.85	0.84	0.84	2.53
Point 3	1.23	1.24	1.22	3.69	2.06	2.08	2.08	6.22	0.85	0.84	0.84	2.53
Point 4	1.21	1.22	1.20	3.63	2.12	2.14	2.14	6.40	0.84	0.84	0.84	2.53
Point 5	1.20	1.20	1.19	3.59	2.06	2.06	2.04	6.16	0.84	0.84	0.84	2.52
G				22.6689				65.6888				10.5504
T				22.6780				65.7004				10.5513
Y				22.6788				65.7015				10.5516

Table 5. (page 3 of 5)

7-11-73 Color IR - Red Band

Replications		Pond 4				Pond 5				Pond 30			
		1	2	3	Total	1	2	3	Total	1	2	3	Total
Point	1	3.20	3.18	3.18	9.56	3.34	3.35	3.34	10.03	3.00	2.91	2.99	8.90
	2	3.20	3.21	3.18	9.59	3.34	3.35	3.32	10.01	3.32	2.98	3.01	9.01
	3	3.18	3.20	3.16	9.54	3.34	3.35	3.33	10.02	2.99	2.99	2.96	8.94
	4	3.19	3.21	3.17	9.57	3.34	3.35	3.32	10.01	2.95	2.97	2.94	8.86
	5	3.20	3.22	3.19	9.61	3.35	3.35	3.33	10.03	2.92	2.92	2.91	8.75
	G				152.7691				167.3340				131.7919
	T				152.7701				167.3341				131.7919
	Y				152.7729				167.3356				131.7988

7-11-73 Normal Color - Green Band

Replications		Pond 4				Pond 5				Pond 30			
		1	2	3	Total	1	2	3	Total	1	2	3	Total
Point	1	1.52	1.52	1.52	4.56	2.44	2.44	2.42	7.30	1.06	1.06	1.06	3.18
	2	1.45	1.45	1.47	4.37	2.37	2.39	2.35	7.11	1.02	1.01	1.00	3.03
	3	1.42	1.42	1.43	4.27	2.31	2.30	2.29	6.90	0.96	0.96	0.96	2.88
	4	1.40	1.41	1.42	4.23	2.16	2.16	2.18	6.50	0.95	0.96	0.96	2.87
	5	1.41	1.41	1.41	4.23	2.19	2.18	2.20	6.57	0.95	0.96	0.96	2.86
	G				31.2770				78.7990				14.6422
	T				31.3031				78.9557				14.6681
	Y				31.3036				78.9574				14.6684

Table 5. (page 4 of 5)

7-12-73 Color IR - Red Band

Replications		Pond 4				Pond 5				Pond 30			
		1	2	3	Total	1	2	3	Total	1	2	3	Total
Point	1	2.99	3.01	2.98	8.98	3.21	3.17	3.21	9.59	2.72	2.73	2.71	8.16
	2	2.95	2.98	2.95	8.88	3.18	3.23	3.19	9.60	2.66	2.67	2.66	7.99
	3	2.86	2.87	2.84	8.57	3.17	3.20	3.17	9.54	2.54	2.56	2.55	7.65
	4	2.73	2.76	2.72	8.21	3.15	3.19	3.16	9.50	2.41	2.42	2.40	7.23
	5	2.65	2.66	2.64	7.95	3.12	3.17	3.14	9.43	2.33	2.32	2.31	6.96
	G				120.9272				151.4217				96.2160
	T				121.1821				151.4382				96.5542
	Y				121.1847				151.4434				96.5551

7-12-73 Normal Color - Green Band

Replications		Pond 4				Pond 5				Pond 30			
		1	2	3	Total	1	2	3	Total	1	2	3	Total
Point	1	1.15	1.14	1.14	3.43	1.73	1.70	1.70	5.13	0.90	0.92	0.89	2.71
	2	1.14	1.13	1.14	3.41	1.71	1.71	1.71	5.13	0.88	0.89	0.86	2.63
	3	1.10	1.12	1.12	3.34	1.74	1.74	1.75	5.23	0.85	0.85	0.84	2.54
	4	1.07	1.07	1.08	3.22	1.73	1.78	1.77	5.28	0.82	0.83	0.81	2.46
	5	1.00	1.01	1.00	3.01	1.78	1.80	1.80	5.38	0.73	0.78	0.78	2.23
	G				17.9525				45.5882				10.5337
	T				17.9924				45.6032				10.5790
	Y				17.9929				45.6055				10.5823

Table 5. (page 5 of 5)

7-13-73 Color IR - Red Band

Replications		Pond 4				Pond 5				Pond 30			
		1	2	3	Total	1	2	3	Total	1	2	3	Total
Point	1	3.16	3.18	3.15	9.49	3.33	3.33	3.34	10.00	2.87	2.88	2.88	8.63
	2	3.14	3.17	3.13	9.44	3.33	3.33	3.34	10.00	2.84	2.87	2.83	8.54
	3	3.12	3.15	3.11	9.38	3.32	3.33	3.33	9.98	2.80	2.81	2.77	8.38
	4	3.12	3.13	3.11	9.36	3.33	3.33	3.33	9.98	2.74	2.75	2.73	8.22
	5	3.13	3.13	3.11	9.37	3.33	3.32	3.33	9.98	2.73	2.75	2.74	8.22
	G				147.5174				166.3335				117.5440
	T				147.5215				166.3336				117.5899
	Y				147.5242				166.3339				117.5921

7-13-73 Normal Color - Green Band

Replications		1	2	3	Total	1	2	3	Total	1	2	3	Total
Point	1	1.36	1.36	1.38	4.10	2.37	2.36	2.40	7.13	1.07	1.07	1.08	3.22
	2	1.39	1.38	1.40	4.17	2.40	2.41	2.42	7.23	1.05	1.05	1.06	3.16
	3	1.40	1.39	1.41	4.20	2.42	2.43	2.44	7.29	1.05	1.05	1.07	3.17
	4	1.41	1.41	1.42	4.24	2.46	2.46	2.46	7.38	1.04	1.03	1.05	3.12
	5	1.45	1.44	1.46	4.35	2.48	2.48	2.49	7.45	1.03	1.03	1.04	3.10
	G				29.5682				88.7194				16.5795
	T				29.5797				88.7402				16.5824
	Y				29.5806				88.7416				16.5831

Figure a. Pond 4.

Figure b. Pond 4.

Figure c. Pond 5.

Figure d. Pond 5.

Figure e. Pond 30.

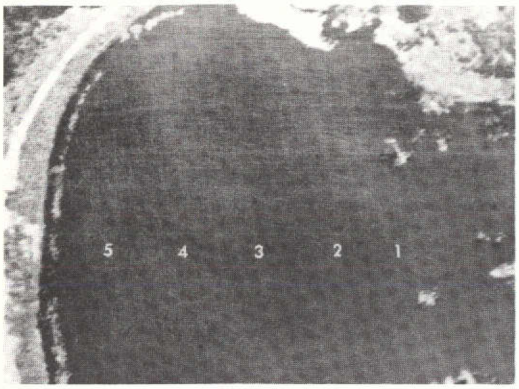
Figure f. Pond 30.

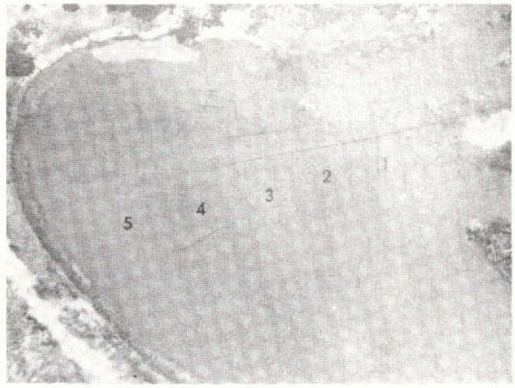
IR Color, Red Band.

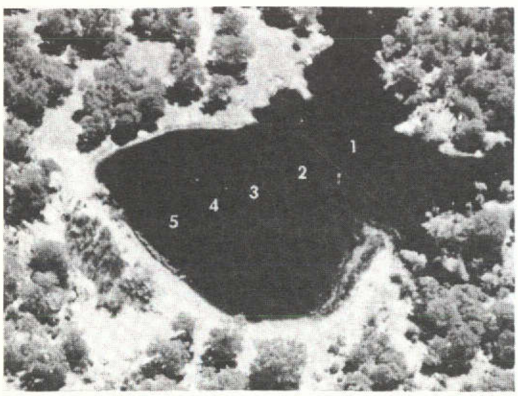
Color, Green Band.

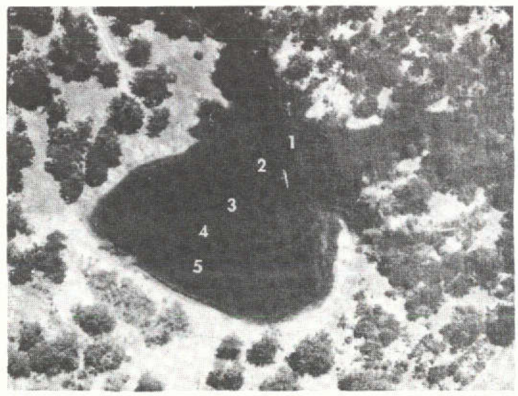
Figure 17. Photos of pond transects for July 4, 1973.

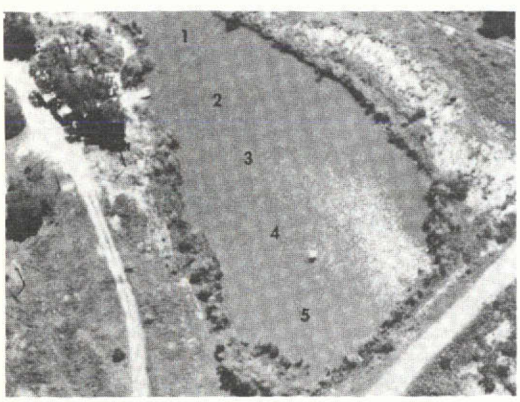
COLOR IR | COLOR











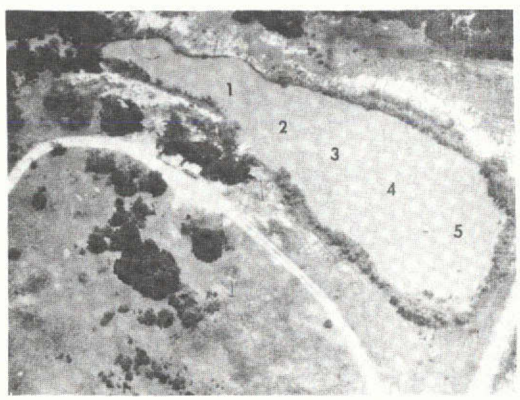


Figure a. Pond 4. Figure b. Pond 4.

Figure c. Pond 5. Figure d. Pond 5.

Figure e. Pond 30. Figure f. Pond 30.

IR Color, Red Band. Color, Green Band.

Figure 18. Photos of pond transects for July 5, 1973.

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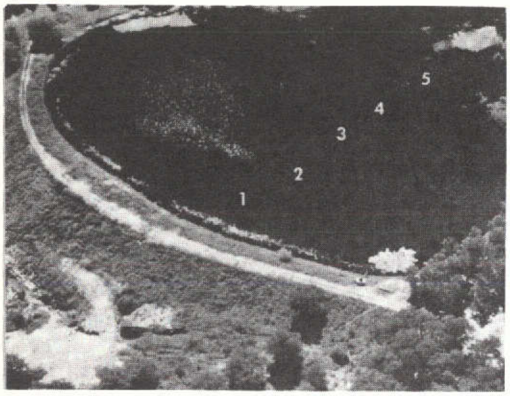
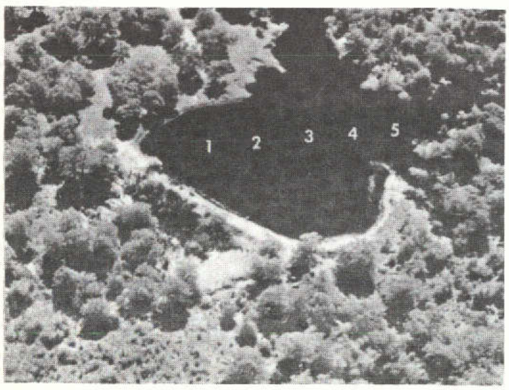
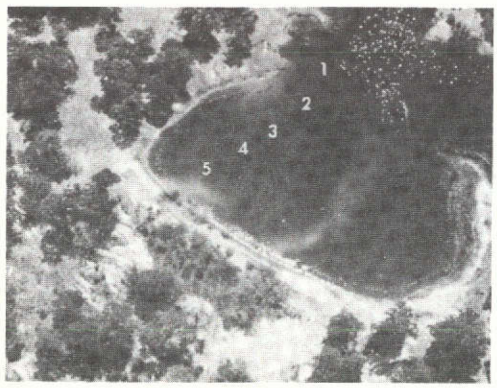
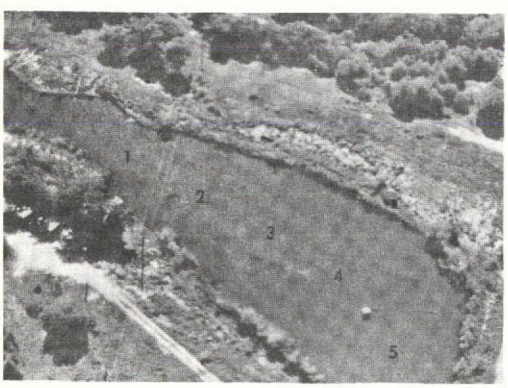
COLOR IR | **COLOR**









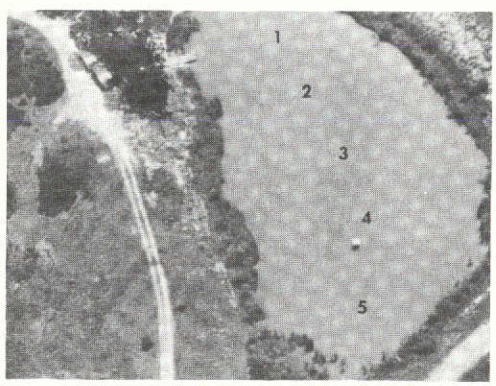


Figure a. Pond 4. Figure b. Pond 4.

Figure c. Pond 5. Figure d. Pond 5.

Figure e. Pond 30. Figure f. Pond 30.

IR Color, Red Band. Color, Green Band.

Figure 19. Photos of pond transects for July 11, 1973.

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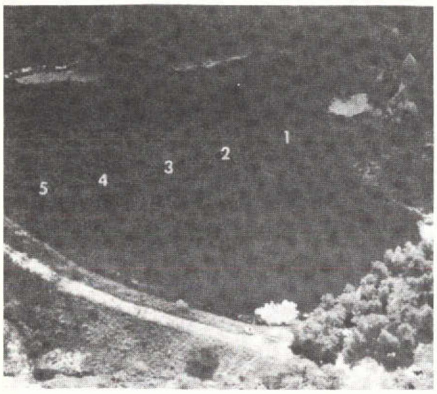

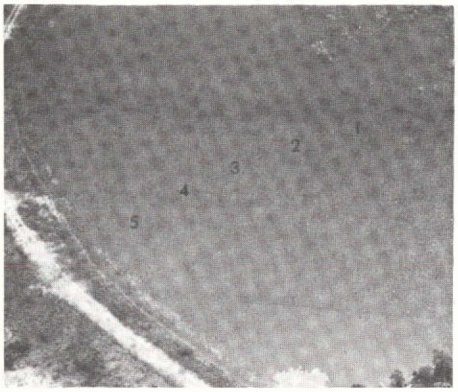

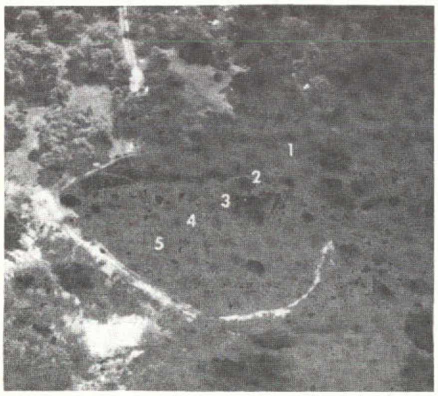

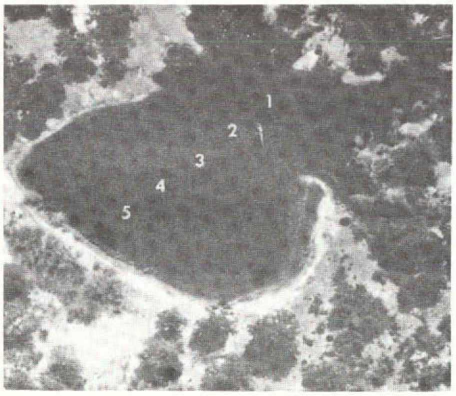

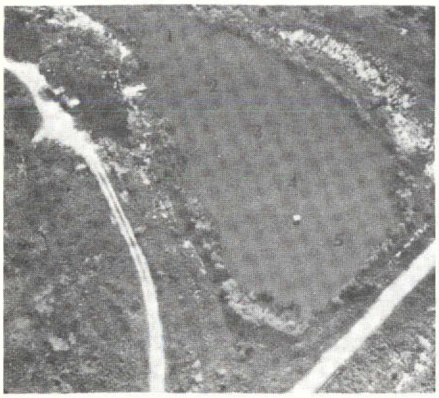

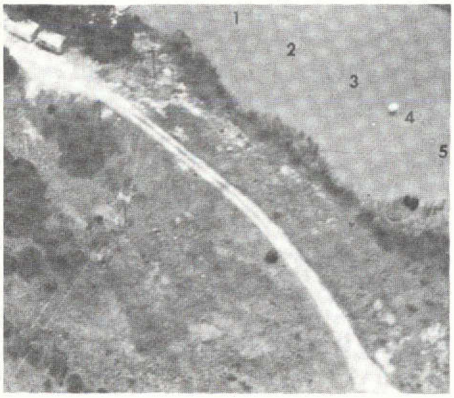

Figure a. Pond 4.

Figure b. Pond 4.

Figure c. Pond 5.

Figure d. Pond 5.

Figure e. Pond 30.

Figure f. Pond 30.

IR Color, Red Band.

Color, Green Band.

Figure 20. Photos of pond transects for July 12, 1973.

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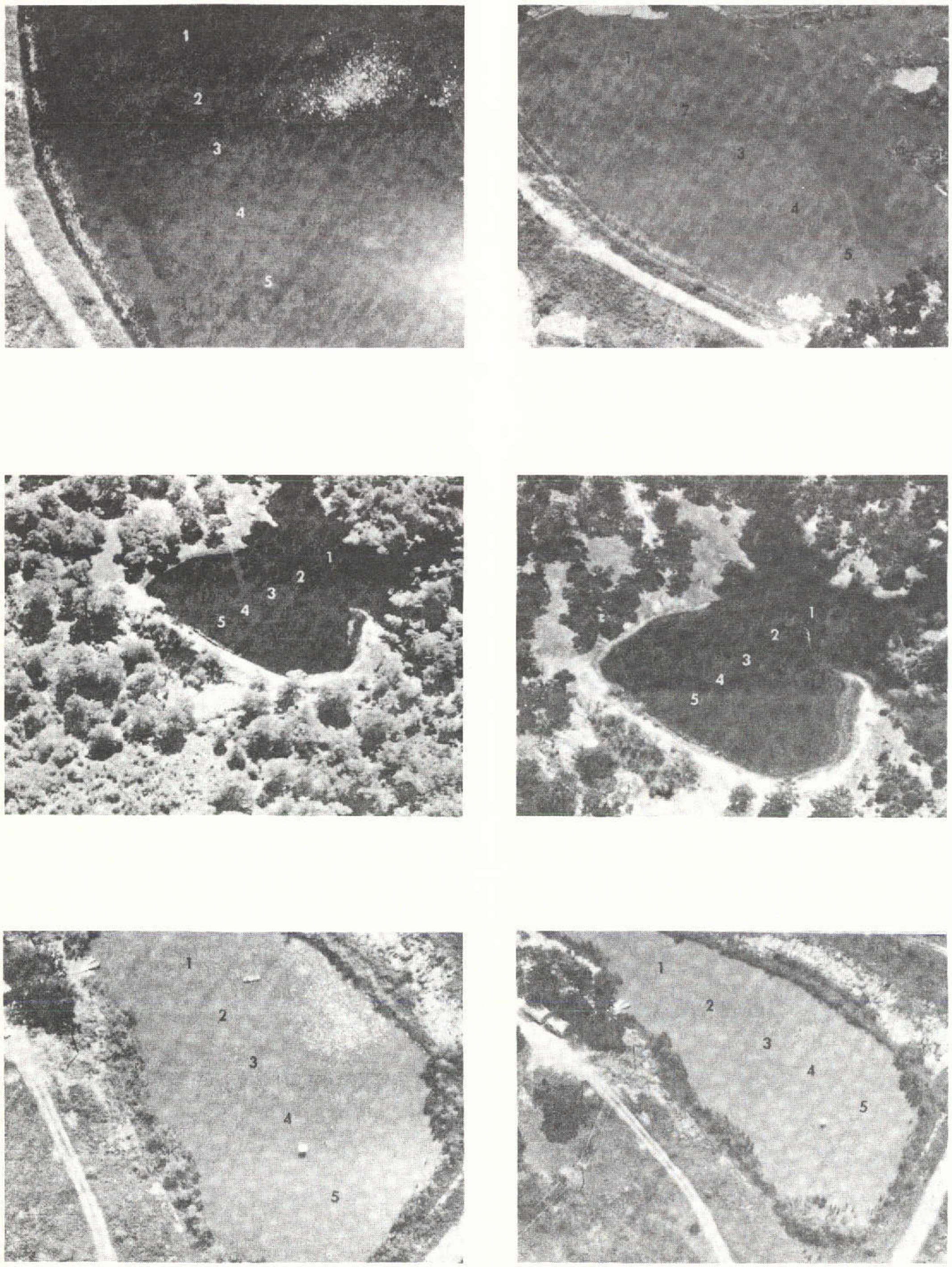

Figure a. Pond 4.

Figure b. Pond 4.

Figure c. Pond 5.

Figure d. Pond 5.

Figure e. Pond 30.

Figure f. Pond 30.

IR Color, Red Band.

Color, Green Band.

Figure 21. Photos of pond transects for July 13, 1973.

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COLOR IR | COLOR

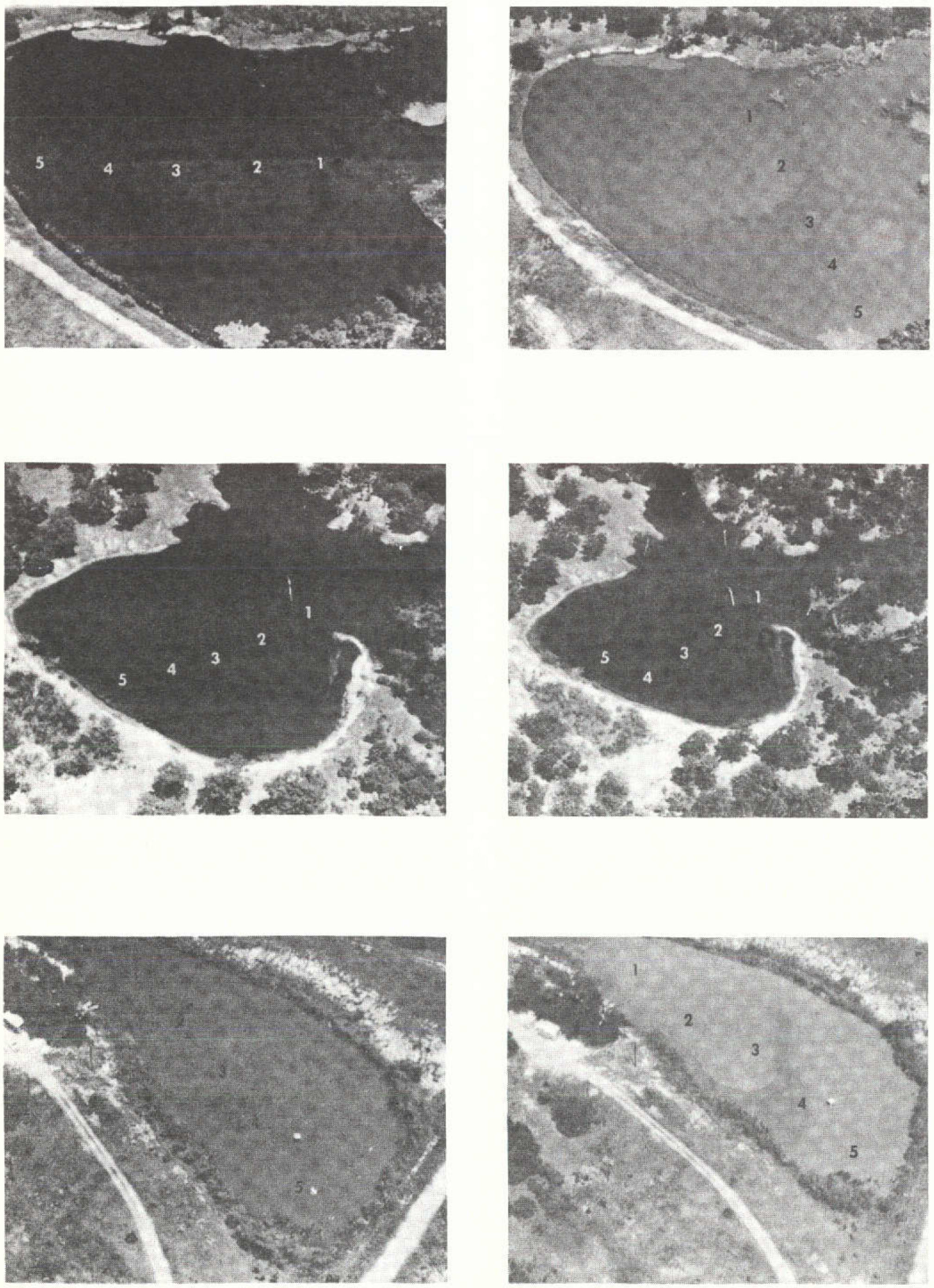


Table 6. Analysis of Variance for Film Density Readings Along Transect Line.

SOURCE		SUM OF SQUARES	D.F.	MEAN SQUARE	CALCULATED F. VALUE
		7-4-73 Color IR - Red Band			
Pond 4	Transect	0.0445	4	0.011125	139
	Point	0.0008	10	0.000080	
	Total	0.0453	14	0.00324	
Pond 5	Transect	0.0001	4	0.000025	0.8
	Point	0.0003	10	0.000030	
	Total	0.0004	14	0.000029	
Pond 30	Transect	0.3010	4	0.07525	396
	Point	0.0019	10	0.00019	
	Total	0.3029	14	0.02164	
		7-4-73 Normal Color - Green Band			
Pond 4	Transect	0.0188	4	0.0047	18.8
	Point	0.0025	10	0.00025	
	Total	0.0213	14	0.00152	
Pond 5	Transect	0.0324	4	0.00810	67.5
	Point	0.0012	10	0.00012	
	Total	0.0336	14	0.0024	
Pond 30	Transect	0.0022	4	0.00055	18.3
	Point	0.0003	10	0.00003	
	Total	0.0025	14	0.000179	

Table 6. (page 2 of 5)

SOURCE		SUM OF SQUARES	D.F.	MEAN SQUARE	CALCULATED F-VALUE
		7-5-73 Color IR - Red Band			
Pond 4	Transect	0.0032	4	0.00080	16.0
	Point	0.0005	10	0.00005	
	Total	0.0037	14	0.00026	
Pond 5	Transect	0.0003	4	0.000075	1.5
	Point	0.0005	10	0.00005	
	Total	0.0008	14	0.000057	
Pond 30	Transect	0.0167	4	0.004175	4.7
	Point	0.0088	10	0.00088	
	Total	0.0255	14	0.00182	
		7-5-73 Normal Color - Green Band			
Pond 4	Transect	0.0091	4	0.002275	28.4
	Point	0.0008	10	0.000080	
	Total	0.0099	14	0.000707	
Pond 5	Transect	0.0116	4	0.00290	26.4
	Point	0.0011	10	0.00011	
	Total	0.0127	14	0.00091	
Pond 30	Transect	0.0009	4	0.000225	7.5
	Point	0.0012	10	0.00012	
	Total	0.0012	14	0.00086	

Table 6. (page 3 of 5)

SOURCE		SUM OF SQUARES	D.F.	MEAN SQUARE	CALCULATED F-VALUE
		7-11-73 Color IR - Red Band			
Pond 4	Transect	0.001	4	0.00025	0.9
	Point	0.0028	10	0.00028	
	Total	0.0038	14	0.00027	
Pond 5	Transect	0.0010	4	0.00025	1.7
	Point	0.0015	10	0.00015	
	Total	0.0016	14	0.00011	
Pond 30	Transect	0.0125	4	0.00313	4.5
	Point	0.0069	10	0.00069	
	Total	0.0194	14	0.00139	
		7-11-73 Normal Color - Green Band			
Pond 4	Transect	0.0261	4	0.00653	131
	Point	0.0005	10	0.00005	
	Total	0.0266	14	0.0019	
Pond 5	Transect	0.1567	4	0.03918	230
	Point	0.0017	10	0.00017	
	Total	0.1584	14	0.01131	
Pond 30	Transect	0.0259	4	0.00648	216
	Point	0.0003	10	0.00003	
	Total	0.0262	14	0.00187	

Table 6. (page 4 of 5)

SOURCE		SUM OF SQUARES	D.F.	MEAN SQUARE	CALCULATED F-VALUE
		7-12-73 Color IR - Red Band			
Pond 4	Transect	0.2549	4	0.0637	245
	Point	0.0026	10	0.00026	
	Total	0.2575	14	0.01839	
Pond 5	Transect	0.0065	4	0.00163	3.1
	Point	0.0052	10	0.00052	
	Totals	0.01170	14	0.00084	
Pond 30	Transect	0.3382	4	0.08455	939
	Point	0.0009	10	0.00009	
	Total	0.3391	14	0.02422	
		7-12-73 Normal Color - Green Band			
Pond 4	Transect	0.0399	4	0.00998	200
	Point	0.0005	10	0.00005	
	Total	0.0404	14	0.00289	
Pond 5	Transect	0.015	4	0.00375	16.3
	Point	0.0023	10	0.00023	
	Total	0.0173	14	0.00124	
Pond 30	Transect	0.0453	4	0.011325	34.3
	Point	0.0033	10	0.00033	
	Total	0.0486	14	0.00347	

Table 6. (page 5 of 5)

SOURCE		SUM OF SQUARES	D.F.	MEAN SQUARE	CALCULATED F-VALUE
		7-13-73 Color IR - Red Band			
Pond 4	Transect	0.0041	4	0.001025	3.8
	Point	0.0027	10	0.00027	
	Total	0.0068	14	0.000486	
Pond 5	Transect	0.0001	4	0.000025	0.8
	Point	0.0003	10	0.00003	
	Total	0.0004	14	0.0000286	
Pond 30	Transect	0.0459	4	0.011475	52.2
	Point	0.0022	10	0.00022	
	Total	0.0481	14	0.00344	
		7-13-73 Normal Color - Green Band			
Pond 4	Transect	0.0115	4	0.00287	31.9
	Point	0.0009	10	0.00009	
	Total	0.0124	14	0.00089	
Pond 5	Transect	0.0208	4	0.0052	37.1
	Point	0.0014	10	0.00014	
	Total	0.0222	14	0.00159	
Pond 30	Transect	0.0029	4	0.000725	10.4
	Point	0.0007	10	0.00007	
	Total	0.0036	14	0.000257	

on one day only. However, this is probably due to a cloud shadow over the pond at the time of the picture. The remaining ponds were all in the critical range in both bands. It is concluded that there is a significant point to point difference within the ponds. These results seem to support the earlier findings of point to point variations. A final statistical analysis was performed on these data to determine whether there is a linear gradation along the transect axis. The results of a t-test calculated for these values are shown in Table 7. The critical range for this t-test was greater than 2.2 at a 95% level of significance and 10 degrees of freedom. The t-values in the critical range indicate that the slope of the regressing line relating position along the transect to film density was greater than zero and a linear gradation is present. In the color infrared red band, Pond 5 was significant only once, on July 12, 1973. Pond 4 was not significant on July 11, 1973. This was probably due to the cloud shadow mentioned in the last section. Pond 30 was not significant on July 5, 1973. This was probably due to a less than optimum angle of photography. In the green band normal color, Pond 5 was not significant on July 5, 1973. Probably due to variations in lighting due to a cloud reflection on the water. The remaining ponds were significant at this level. The variation in film

Table 7. T-test Values for Transect Readings

Date	Pond	Red Band CIR 1/	Green Band Color
7-4-73	4	21.8	-7.0
	5	-0.3	-16.3
	30	-17.2	-8.1
7-5-73	4	8.9	-11.5
	5	2.2	-1.4
	30	1.2	2.3
7-11-73	4	0.8	-7.3
	5	0.0	10.9
	30	-2.6	-7.5
7-12-73	4	-18.9	-9.5
	5	-3.6	7.5
	30	-26.3	-9.5
7-13-73	4	-3.6	9.6
	5	0.3	13.7
	30	-10.9	-5.9

1/ CIR = Color infrared

density within the ponds can be due to several factors including:

1) variation in turbidity within the ponds,
2) for the less turbid ponds a variation in depth of the water could result in a variation in the light reflected from the bottom,
3) changes in the angle at the pond between a vector from the surface to the camera and a vector from the sun to the surface,
4) changes in the angle at the camera station from vertical to a particular point in the pond surface and
5) cloud shadows or cloud reflections.

The variation of the turbidity within the ponds was measured by taking three water samples in each of the ponds. The computed standard error of the turbidity observations are listed in Appendix B. The average turbidity values in ponds 4, 5, and 30 were 23, 6 and 29 JTU with standard deviation of 0.3, 0.5, and 0.2, respectively. The low variation in turbidity values within the ponds was not considered to have a large effect on the film density. Since pond 5 was very clear, its variations may be due to light reflected from the bottom.

In a study of this nature where hand held cameras are used, care must be taken to minimize the changes in the camera station exposure geometry. In this study the angles listed under items 3 and 4 above were approximately 30 degrees. These angles are a function of position and change

from point to point within the frame.

On four days, July 5, 11, 12 and 13, photographs of the ponds were taken twice on the same roll of film. Film density readings were measured of the ponds on each flight and are listed in Table 8 for the red band of the infrared color film and the green band of the color film.

The largest differences in densities occurred July 11 and 12. The hypothesis that there is not a consistent difference between the densities measured on the photos of the two flights was tested. The statistic was computed by dividing the mean difference in film densities between flights by the estimated standard deviation of the mean. The critical range for a two-tail t-test with 5 degrees of freedom and a 95 percent confidence level is 2.6. The computed t statistic is shown in Table 8. The t values were -0.6, 1.7, -0.8, 4.0, -1.0, 1.6, 0.2, and 0.2. Only for the green band on July 11, was the t-statistic in the critical range. The hypothesis cannot be rejected, and it is concluded that there is no significant difference in film density readings between flights.

Chlorophyll

Chlorophyll measurements were made as part of the field program. An effort was made to correlate these readings with the ratios of selected pass bands recorded

Table 8. Film density readings for repetitive flights

Date	Pond	Red Band Color IR						Green Band Color					
		Flight 1		Flight 2		Diff		Flight 1		Flight 2		Diff	
		Time	Den	Time	Den	Time	Den	Time	Den	Time	Den	Time	Den
7/5/73	1	1053	0.68	1104	0.62	11	-0.08	1126	0.54	1140	0.54	14	0.00
	2	1051	3.11	1059	2.95	8	-0.16	1125	1.13	1135	1.03	10	-0.10
	3	1052	3.28	1101	3.21	9	-0.07	1129		1134	1.66	5	
	4	1049	3.24	1058	3.22	7	-0.02	1124	1.24	1136	1.19	12	-0.05
	5	1055	3.37	1102	3.35	7	-0.02	1127	1.94	1142	2.11	15	-0.17
	30	1048	2.90	1057	2.84	9	-0.06	1123	0.87	1133	0.85	10	-0.02
	M						-0.068						-0.085
	S						0.282						0.098
	Sm						0.115						0.0491
	t						-0.597						-1.73
7/11/73	1	1134	0.98	1140	1.16	6	0.18	1212	0.62	1219	0.75	7	0.13
	2	1131	3.27	1138	2.96	7	-0.31	1209	1.19	1215	1.69	6	0.50
	3	1133	3.26	1139	3.21	6	-0.05	1211	1.84	1217	2.13	6	0.29
	4	1130	3.33	1136	3.10	6	-0.13	1207	1.34	1214	1.50	7	0.24
	5	1131	3.38	1136	3.35	5	-0.03	1207	2.25	1214	2.31	7	0.06
	30	1130	2.95	1136	2.96	6	0.02	1207	0.95	1214	1.35	7	0.40
	M						-0.053						0.27
	S						0.163						0.164
	Sm						0.066						0.067
	t						-0.808						4.02

M = mean
Sm = Standard deviation of the mean

t = calculated t-value
S = Standard deviation of the observation

Table 8. (Continued)

Date	Pond	Red Band Color IR						Green Band Color					
		Flight 1		Flight 2		Diff		Flight 1		Flight 2		Diff	
		Time	Den	Time	Den	Time	Den	Time	Den	Time	Den	Time	Den
7/12/73	1	1134	0.69	1142	0.70	8	0.01	1215	0.60	1222	0.55	7	-0.05
	2	1132	2.06	1138	2.10	6	0.04	1212	1.21	1219	1.15	7	-0.06
	3	1132	2.78	1140	2.74	8	-0.04	1213	1.75	1220	1.69	7	-0.06
	4	1130	2.71	1138	2.55	8	-0.16	1210	1.07	1217	1.50	7	0.43
	5	1131	3.16	1140	3.21	9	0.05	1210	1.76	1217	2.34	7	0.58
	30	1130	2.43	1136	2.33	6	-0.10	1210	0.83	1216	1.07	6	0.24
	M						-0.033						0.180
	S						0.083						0.281
	Sm						0.034						0.115
	t						-0.980						0.157
7/13/73	1	1420	0.89	1428	0.83		-0.06	1502	0.68	1510	0.69	8	0.01
	2	1416	2.86	1424	2.91	8	0.05	1500	1.24	1507	1.24	7	0.00
	3	1418	3.24	1428	3.23	10	-0.01	1501	1.86	1508	1.82	7	-0.04
	4	1414	3.13	1422	3.13	8	0.00	1458	1.34	1505	1.40	7	0.01
	5	1414	3.35	1422	3.36	8	0.01	1458	2.42	1505	2.45	7	0.03
	30	1414	2.80	1420	2.86	6	0.06	1450	1.07	1505	1.05	15	-0.02
	M						0.008						-0.0017
	S						0.106						0.025
	Sm						0.043						0.010
	t						0.193						0.166

M = mean
Sm = Standard deviation of the mean
t = calculated t-value
S = Standard deviation of the observation

on black and white film. The pass bands were chosen in the areas of maximum absorption of light by chlorophyll, with reference bands in areas of minimum absorption. However, due to the masking effect of the total turbidity no conclusive relationship could be established between the ratio of light scattered in the band of minimum light absorption and the band of maximum light absorption. An unfortunate quirk of nature yielded the highest chlorophyll in the pond with the greatest turbidity and the lowest turbidity corresponded to the lowest chlorophyll readings. Chlorophyll was found to correlate fairly well with the same equation used for the high range of turbidity. On the basis of these results it would have to be said that the two parameters were indistinguishable with the film and filter combinations used in this experiment. The photographic measurements were indirectly related to chlorophyll through turbidity. Figure 22 demonstrates the relationship between chlorophyll and the exponential of the difference between the color infrared red band reading and the red band reading of the gray card. The correlation coefficient between the photographic value and the chlorophyll measurements was 0.903. From the plot of turbidity vs chlorophyll shown in Figure 23, a close relationship can be observed. The correlation coefficient between the turbidity and chlorophyll values was 0.920.

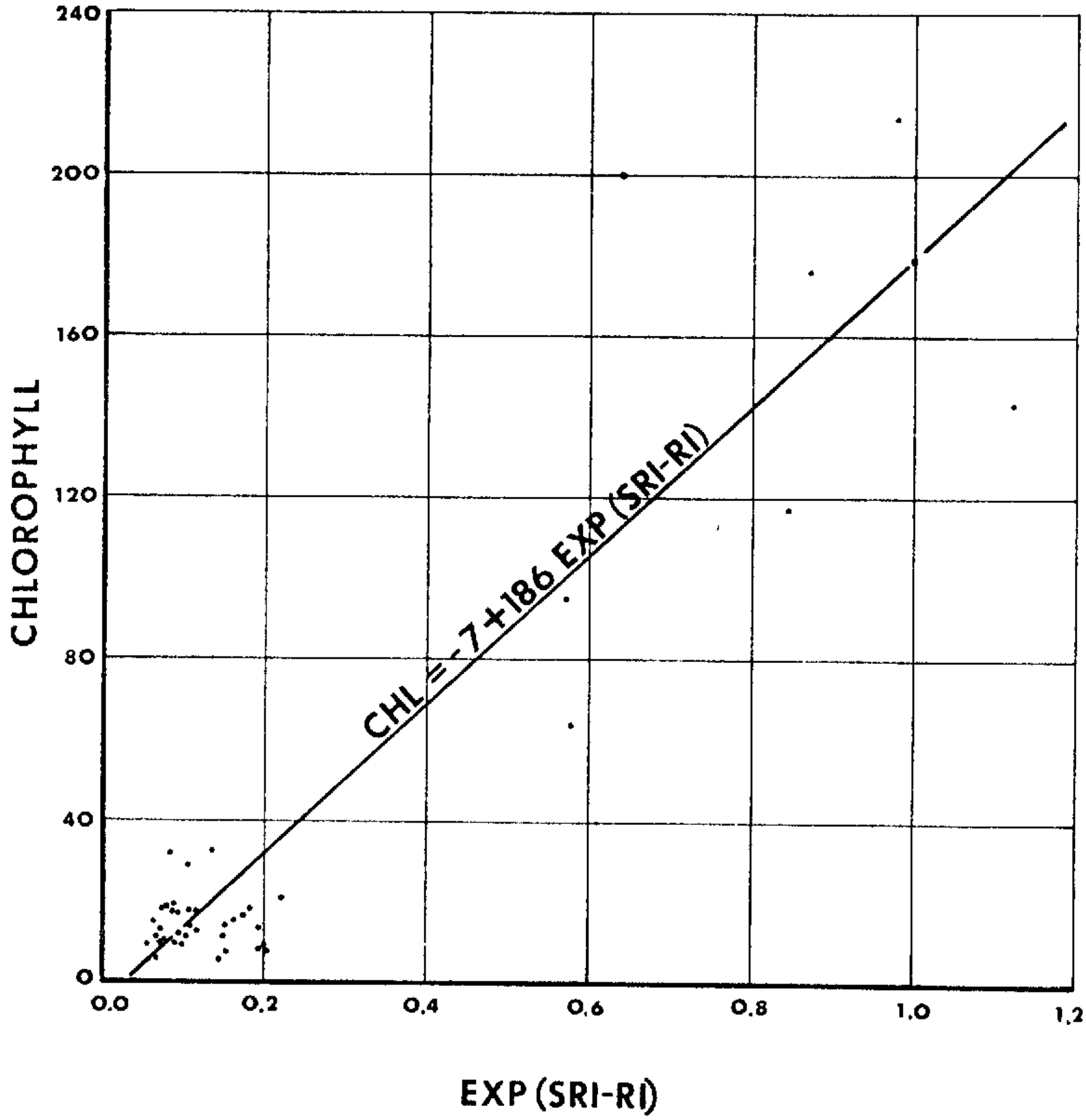
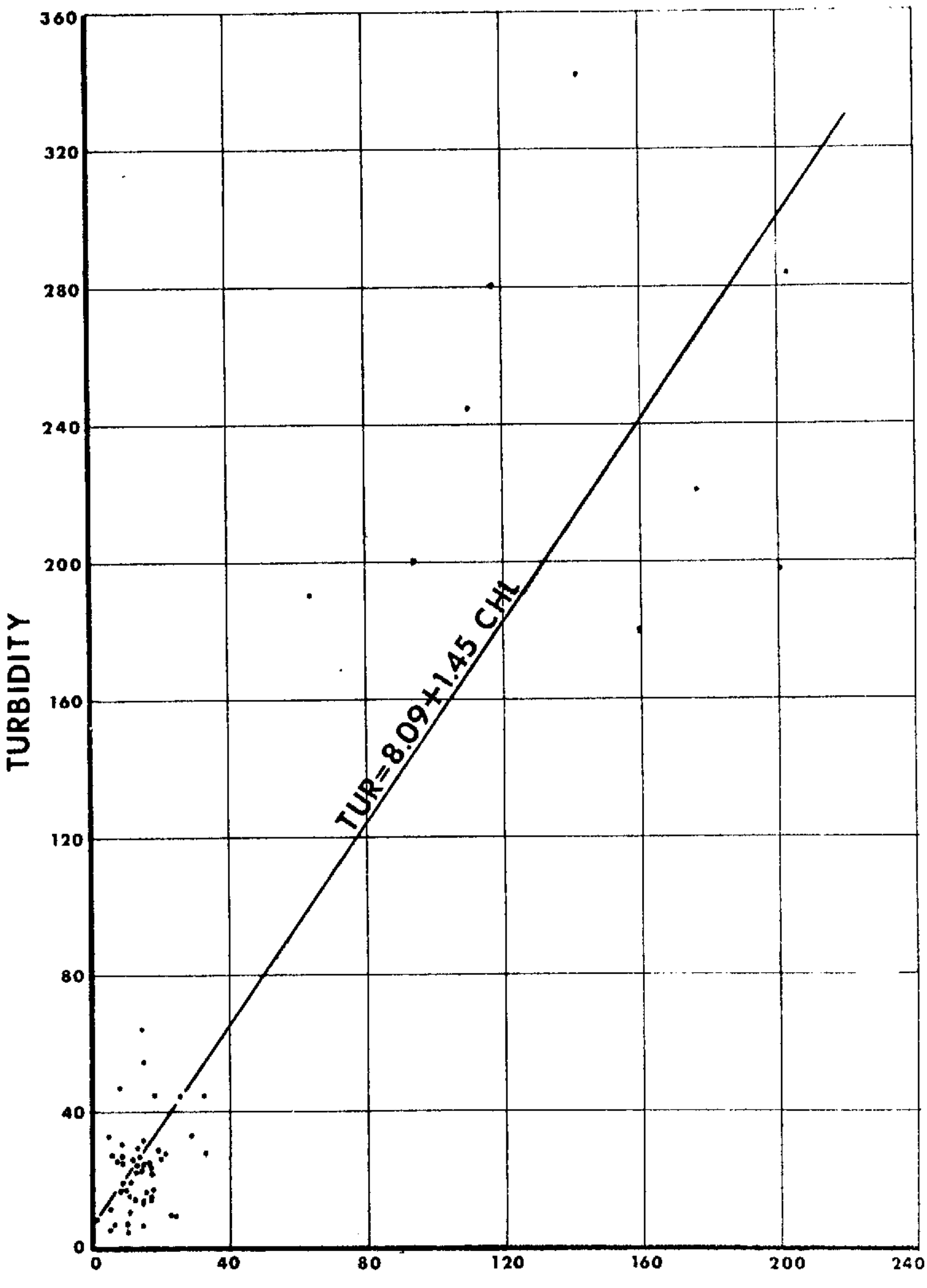


Figure 22. Plot of chlorophyll and the exponential of the color infrared, red band reading minus the gray card correction.

Figure 23. Plot of turbidity against chlorophyll.


360
320
280
240
200
160
120
80
40
0
TURBIDITY
TUR=8.09+1.45 CHL
0
40
80
120
160
200
240
CHLOROPHYLL

In summary, there are no significant differences in replicate density readings at the same point on the film. There is little difference between turbidity measurements on samples taken from different parts of the ponds. There are significant differences between density readings taken from different points in the pond.

CONCLUSIONS AND RECOMMENDATIONS

It has been demonstrated that a valid relationship exists between film density values and quantitative turbidity measurements. A high degree of confidence can be placed in such a system of synoptic sampling.

It should be noted that the best results were obtained when the system was standardized against a gray card. It is recommended that the gray card be photographed before and after aerial photographs are taken. The same camera settings that were used for the aerial photogarphy should be used to photograph the gray card.

It is recommended that a two camera system be used to record turbidity. One camera should use color infrared film and the other should use color film. This is necessary to cover the broad range of turbidities one might encounter in a synoptic overflight of several lakes and ponds.

Three recommendations are advanced at this point in an effort to limit point to point variability:

1) Measurements should be taken close to the center of the photo to eliminate camera lens fall-off.

2) The angle between the incident sun light on the pond and the camera axis should be constant. One way would be to always include the shadow of the plane in the upper right corner of the photo to fix the camera's relationship to sun angle.

3) Maintain a constant time frame for day to day repetitions to keep sun within optimum altitide range of 30° to 60° above the horizon.

Two recommendations are foremost for perfecting a camera chlorophyll detection system. Narrow pass band interference filters should be used to reduce the interference caused by turbidity. The broad band filters and filter combinations used in this study proved to be inadequate for this purpose. Secondly, the testing of the system should be performed on ponds or lakes selected for their high chlorophyll content in relation to relatively low turbidity. The test should be designed to determine the lower limit of concentration detectable under various conditions. Additional studies should be conducted to develop the techniques for aerial photographic monitoring of chlorophyll in natural aquatic situations.

The final assessment of this study points to the success of the ability to detect turbidity. Further investigation is necessary to provide for the detection of chlorophyll on a quantitative basis.

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A P P E N D I X A

PHOTOGRAPHIC EXPOSURE DATA

KEY

TX	=	Tri-X high speed black and white film
HIE	=	High speed black and white infrared film
EH	=	High speed Ektachrome color film
IE	=	Ektachrome color infrared film
12	=	Wratten 12 filter
47	=	Wratten 47 and 12 filters together
50	=	Wratten 50 filter
92	=	Wratten 92 filter
55	=	Wratten 55 and 12 filters together
P	=	Polarizing filter
89B	=	Wratten 89 B filter
SPD	=	Shutter speed in seconds
F #	=	F number
FM:	=	Film type
FL:	=	Filter (s)

Table A-1. Airphoto Data, May 3, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92		FM:HIE FL:P+89B		FM:IE FL:P+12		FM:EH FL:P		FM: FL:		FM: FL:	
		F #	SPD	F #	SPD	F #	SPD	F #	SPD	F #	SPD	F #	SPD
1357	30	1.4	1/30	11	1/250	5.6	1/125						
1359	4	1.4	1/30	11	1/250	5.6	1/125						
1400	2	1.4	1/30	11	1/250	5.6	1/125						
1402	3	1.4	1/30	11	1/250	5.6	1/125						
1404	1	1.4	1/30	11	1/250	5.6	1/125						
1408	5	1.4	1/30	11	1/250	5.6	1/125						
1416	30	1.4	1/15	11	1/250	5.6	1/125						
1418	4	1.4	1/15	11	1/250	5.6	1/125						
1420	2	1.4	1/15	11	1/250	5.6	1/125						
1421	1	1.4	1/15	11	1/250	5.6	1/125						
1425	3	1.4	1/15	11	1/250	5.6	1/125						
1427	5	1.4	1/15	11	1/250	5.6	1/125						
1441	30	1.4	1/15	11	1/250			4	1/250				
1442	4	1.4	1/15	11	1/250			4	1/250				
1444	2	1.4	1/15	11	1/250			4	1/250				
1446	3	1.4	1/15	11	1/250			4	1/250				
1449	1	1.4	1/15	11	1/250			4	1/250				
1451	5	1.4	1/15	11	1/250			4	1/250				

Table A-2. Airphoto Data, May 7, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92		FM:HIE FL:P+89B		FM:IE FL:P+12		FM:EH FL:P		FM: FL:		FM: FL:	
		F #	SPD	F #	SPD	F #	SPD	F #	SPD	F #	SPD	F #	SPD
1158	30	1.4	1/60	16	1/500	5.6	1/125						
1158	4	1.4	1/60	16	1/500	5.6	1/125						
1200	2	1.4	1/60	16	1/500	5.6	1/125						
1202	3	1.4	1/60	16	1/500	5.6	1/125						
1204	1	1.4	1/60	16	1/500	5.6	1/125						
1206	1	1.4	1/60	16	1/500	5.6	1/125						
1215	30	1.4	1/125	11	1/500			4	1/250				
1215	4	1.4	1/125	11	1/500			4	1/250				
1215	2	1.4	1/125	11	1/500			4	1/250				
1216	2	1.4	1/125	11	1/500			4	1/250				
1218	3	1.4	1/125	11	1/500			4	1/250				
1220	1	1.4	1/125	11	1/500			4	1/250				
1222	5	1.4	1/125	11	1/500			4	1/250				

Table A-3. Airphoto Data, May 10, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92		FM:HIE FL:P+89B		FM:IE FL:P+12		FM:EH FL:P		FM: FL:		FM: FL:	
		F #	SPD	F #	SPD	F #	SPD	F #	SPD	F #	SPD	F #	SPD
1205	30	1.4	1/125	5.6	1/125	5.6	1/125						
1205	4	1.4	1/125	5.6	1/125	5.6	1/125						
1208	2	1.4	1/125	5.6	1/125	5.6	1/125						
1210	1	1.4	1/125	5.6	1/125	5.6	1/125						
1212	3	1.4	1/125	5.6	1/125	5.6	1/125						
1215	5	1.4	1/125	5.6	1/125	5.6	1/125						
1220	30	1.4	1/125	8	1/125			4	1/250				
1220	4	1.4	1/125	8	1/125			4	1/250				
1222	2	1.4	1/125	8	1/125			4	1/250				
1223	3	1.4	1/125	8	1/125			4	1/250				
1225	1	1.4	1/125	8	1/125			4	1/250				
1227	5	1.4	1/125	8	1/125			4	1/250				

Table A-4. Airphoto Data, May 16, 1973.

TIME	POND	FM: TX		FM: HIE		FM: IE		FM: EH		FM:		FM:	
CDT	NO.	EL: P+92		FL: P+89B		FL: P+12		FL: P		FL:		FL:	
		F#	SPD	F#	SPD	F#	SPD	F#	SPD	F#	SPD	F#	SPD
1207	30	1.4	1/125	8	1/125	5.6	1/125						
1207	4	1.4	1/125	8	1/125	5.6	1/125						
1209	2	1.4	1/125	8	1/125	5.6	1/125						
1211	3	1.4	1/125	8	1/125	5.6	1/125						
1212	1	1.4	1/125	8	1/125	5.6	1/125						
1214	5	1.4	1/125	8	1/125	5.6	1/125						
1219	30	1.4	1/125	8	1/250			4	1/250				
1219	4	1.4	1/125	8	1/250			4	1/250				
1220	2	1.4	1/125	8	1/250			4	1/250				
1222	3	1.4	1/125	8	1/250			4	1/250				
1224	1	1.4	1/125	8	1/250			4	1/250				
1225	5	1.4	1/125	8	1/250			4	1/250				

Table A-5. Airphoto Data, May 18, 1973.

TIME CDT	POND NO.	FM: TX FL: P+92 F#	SPD	FM: HIE FL: P+89B F#	SPD	FM: IE FL: P+12 F#	SPD	FM: EH FL: P F#	SPD	FM: FL: F#	SPD	FM: FL: F#	SPD
1211	30	1.4	1/125	8	1/125	5.6	1/125						
1211	4	1.4	1/125	8	1/125	5.6	1/125						
1212	2	1.4	1/125	8	1/125	5.6	1/125						
1215	3	1.4	1/125	8	1/125	5.6	1/125						
1216	1	1.4	1/125	8	1/125	5.6	1/125						
1218	5	1.4	1/125	8	1/125	5.6	1/125						
1223	30	1.4	1/125	8	1/125			4	1/250				
1224	4	1.4	1/125	8	1/125			4	1/250				
1225	2	1.4	1/125	8	1/125			4	1/250				
1227	3	1.4	1/125	8	1/125			4	1/250				
1228	1	1.4	1/125	8	1/125			4	1/250				
1230	5	1.4	1/125	8	1/125			4	1/250				

Table A-6. Airphoto Data, May 28, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92	FM:HIE FL:P+89B	FM:IE FL:P+12	FM:EH FL:P	FM: FL:	FM: FL:
		F# SPD	F# SPD	F# SPD	F# SPD	F# SPD	F# SPD
1205	30	1.4 1/125	11 1/250	5.6 1/125			
1205	4	1.4 1/125	11 1/250	5.6 1/125			
1207	2	1.4 1/125	11 1/250	5.6 1/125			
1209	3	1.4 1/125	11 1/250	5.6 1/125			
1211	1	1.4 1/125	11 1/250	5.6 1/125			
1213	5	1.4 1/125	16 1/250	5.6 1/125			
1216	30	1.4 1/125	16 1/500		4 1/250		
1217	4	1.4 1/125	16 1/500		4 1/250		
1220	2	1.4 1/125	16 1/500		4 1/250		
1222	3	1.4 1/125	16 1/500		4 1/250		
1224	1	1.4 1/125	16 1/500		4 1/250		
1225	5	1.4 1/125	16 1/500		4 1/250		

Table A-7. Airphoto Data, May 30, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92 F # SPD	FM:HIE FL:P+89B F # SPD	FM:1E FL:P+12 F # SPD	FM:EH FL:P F # SPD	TM:TX FL:P+50 F # SPD	FM:TX FL:P+47 F # SPD
1214	30	1.8 1/125	11 1/250	5.6 1/125			
1216	4	1.8 1/125	11 1/250	5.6 1/125			
1218	2	1.8 1/125	11 1/250	5.6 1/125			
1220	3	1.8 1/125	11 1/250	5.6 1/125			
1221	1	1.8 1/125	11 1/250	5.6 1/125			
1223	5	1.8 1/125	11 1/250	5.6 1/125			
1244	30				4 1/250	5.6 1/250	2 1/250
1244	4				4 1/250	5.6 1/250	2 1/250
1244	2				4 1/250	5.6 1/250	2 1/250
1244	3				4 1/250	5.6 1/250	2 1/250
1245	1				4 1/250	5.6 1/250	2 1/250
1247	30				4 1/250	5.6 1/250	2 1/250
1249	4				4 1/250	5.6 1/250	2 1/250

Table A-8. Airphoto Data, June 6, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92 F # SPD	FM:HIE FL:P+89B F # SPD	FM:IE FL:P+12 F # SPD	FM:EH FL:P F # SPD	FM:TX FLP+50 F # SPD	FM:TX FL:P+55 F # SPD
1400	30	1.8 1/125	11 1/250	5.6 1/125			
1400	4	1.8 1/125	11 1/250	5.6 1/125			
1401	2	1.8 1/125	11 1/250	5.6 1/125			
1403	3	1.8 1/125	11 1/250	5.6 1/125			
1405	1	1.8 1/125	11 1/250	5.6 1/125			
1407	5	1.8 1/125	11 1/250	5.6 1/125			
1429	30				5.6 1/250	5.6 1/250	2.8 1/125
1430	4				5.6 1/250	5.6 1/250	2.8 1/125
1431	2				5.6 1/250	5.6 1/250	2.8 1/125
1433	3				5.6 1/250	5.6 1/250	2.8 1/125
1435	1				5.6 1/250	5.6 1/250	2.8 1/125
1437	5				5.6 1/250	5.6 1/250	2.8 1/125

Table A-9. Airphoto Data, June 26, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92 F # SPD	FM:HIE FL:P+89B F # SPD	FM:IE FL:P+12 F # SPD	FM:EH FL:P F # SPD	FM:TX FL:P+50 F # SPD	FM:TX FL:P+55 F # SPD
1216	30	1.8 1/125	11 1/250	5.6 1/125			
1216	4	1.8 1/125	11 1/250	5.6 1/125			
1218	2	1.8 1/125	11 1/250	5.6 1/125			
1219	3	1.8 1/125	11 1/250	5.6 1/125			
1221	1	1.8 1/125	11 1/250	5.6 1/125			
1222	5	1.8 1/125	11 1/250	5.6 1/125			
1224	30	1.8 1/125	11 1/250	5.6 1/125			
1224	4	1.8 1/125	11 1/250	5.6 1/125			
1226	2	1.8 1/125	11 1/250	5.6 1/125			
1227	3	1.8 1/125	11 1/250	5.6 1/125			
1228	1	1.8 1/125	11 1/250	5.6 1/125			
1229	5	1.8 1/125	11 1/250	5.6 1/125			
1258	30				5.6 1/250	4 1/250	5.6 1/125
1259	4				5.6 1/250	4 1/250	5.6 1/125
1301	2				5.6 1/250	4 1/250	5.6 1/125
1302	3				5.6 1/250	4 1/250	5.6 1/125
1304	3				5.6 1/250	4 1/250	5.6 1/125
1305	1				5.6 1/250	4 1/250	5.6 1/125
1307	5				5.6 1/250	4 1/250	5.6 1/125
1309	30				5.6 1/250	4 1/250	5.6 1/125
1309	4				5.6 1/250	4 1/250	5.6 1/125
1310	2				5.6 1/250	4 1/250	5.6 1/125
1312	3				5.6 1/250	4 1/250	5.6 1/125
1313	1				5.6 1/250	4 1/250	5.6 1/125
1314	5				5.6 1/250	4 1/250	5.6 1/125

Table A-10. Airphoto Data, July 4, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92 F # SPD	FM:HIE FL:P+89B F # SPD	FM:IE FL:P+12 F # SPD	FM:EH FL:P F # SPD	FM:TX FL:P+50 F # SPD	FM:TX FL:P+55 F # SPD
1134	30	1.8 1/125	11 1/250	4 1/250			
1134	4	1.8 1/125	11 1/250	4 1/250			
1136	2	1.8 1/125	11 1/250	4 1/250			
1137	3	1.8 1/125	11 1/250	4 1/250			
1139	1	1.8 1/125	11 1/250	4 1/250			
			-FILM CHANGE-				
1227	4	1.8 1/125	11 1/250	4 1/250			
1228	4	1.8 1/125	11 1/250	4 1/250			
1230	30	1.8 1/125	11 1/250	4 1/250			
1234	5	1.8 1/125	11 1/250	4 1/250			
1236	2	1.8 1/125	11 1/250	4 1/250			
1238	1	1.8 1/125	11 1/250	4 1/250			
1303	30				5.6 1/250	4 1/250	4 1/250
1305	4				5.6 1/250	4 1/250	4 1/250
1306	3				5.6 1/250	4 1/250	4 1/250
1308	5				5.6 1/250	4 1/250	4 1/250
1315	5				5.6 1/250	4 1/250	4 1/250
1317	3				5.6 1/250	4 1/250	4 1/250
1319	1				5.6 1/250	4 1/250	4 1/250
			-FILM CHANGE-			No Change	
1342	4				5.6 1/250	4 1/250	4 1/250
1344	30				5.6 1/250	4 1/250	4 1/250
1346	2				5.6 1/250	4 1/250	4 1/250
1347	1				5.6 1/250	4 1/250	4 1/250
1348	3				5.6 1/250	4 1/250	4 1/250

Table A-11. Airphoto Data, July 5, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92		FM: HIE FL:P+89B		FM:IE FL:P+12		FM:EH FL:P		FM:TX FL:P+50		FM:TX FL:P+55	
		F #	SPD	F #	SPD	F #	SPD	F #	SPD	F #	SPD	F #	SPD
1044	TEST	1.8	1/125	11	1/250	4	1/250						
1049	30	1.8	1/125	11	1/250	4	1/250						
1049	4	1.8	1/125	11	1/250	4	1/250						
1050	2	1.8	1/125	11	1/250	4	1/250						
1052	3	1.8	1/125	11	1/250	4	1/250						
1053	1	1.8	1/125	11	1/250	4	1/250						
1055	5	1.8	1/125	11	1/250	4	1/250						
1057	30	1.8	1/125	11	1/250	4	1/250						
1057	4	1.8	1/125	11	1/250	4	1/250						
1058	2	1.8	1/125	11	1/250	4	1/250						
1100	3	1.8	1/125	11	1/250	4	1/250						
1102	5	1.8	1/125	11	1/250	4	1/250						
1103	1	1.8	1/125	11	1/250	4	1/250						
1123	30							5.6	1/250	4	1/250	4	1/250
1124	4							5.6	1/250	4	1/250	4	1/250
1125	2							5.6	1/250	4	1/250	4	1/250
1126	1							5.6	1/250	4	1/250	4	1/250
1127	5							5.6	1/250	4	1/250	4	1/250
1129	3							5.6	1/250	4	1/250	4	1/250
1130	5							5.6	1/250	4	1/250	4	1/250
1133	4							5.6	1/250	4	1/250	4	1/250
1135	2							5.6	1/250	4	1/250	4	1/250
1136	3							5.6	1/250	4	1/250	4	1/250
1140	1							5.6	1/250	4	1/250	4	1/250
1142	5							5.6	1/250	4	1/250	4	1/250

Table A-12. Airphoto Data, July 11, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92 F # SPD	FM:HIE FL:P+89B F # SPD	FM:IE FL:P+12 F # SPD	FM:EH FL:P F # SPD	FM:TX FL:P+50 F # SPD	FM:TX FL:P+55 F # SPD
1130	30	1.8 1/125	11 1/250	4 1/250			
1130	4	1.8 1/125	11 1/250	4 1/250			
1131	5	1.8 1/125	11 1/250	4 1/250			
1131	2	1.8 1/125	11 1/250	4 1/250			
1133	3	1.8 1/125	11 1/250	4 1/250			
1134	1	1.8 1/125	11 1/250	4 1/250			
1136	30	1.8 1/125	11 1/250	4 1/250			
1136	4	1.8 1/125	11 1/250	4 1/250			
1136	5	1.8 1/125	11 1/250	4 1/250			
1138	2	1.8 1/125	11 1/250	4 1/250			
1139	2	1.8 1/125	11 1/250	4 1/250			
1140	1	1.8 1/125	11 1/250	4 1/250			
1207	30				5.6 1/250	4 1/250	4 1/250
1207	4				5.6 1/250	4 1/250	4 1/250
1207	5				5.6 1/250	4 1/250	4 1/250
1209	2				5.6 1/250	4 1/250	4 1/250
1211	3				5.6 1/250	4 1/250	4 1/250
1212	1				5.6 1/250	4 1/250	4 1/250
1214	30				5.6 1/250	4 1/250	4 1/250
1214	4				5.6 1/250	4 1/250	4 1/250
1214	5				5.6 1/250	4 1/250	4 1/250
1215	2				5.6 1/250	4 1/250	4 1/250
1217	3				5.6 1/250	4 1/250	4 1/250
1219	1				5.6 1/250	4 1/250	4 1/250

Table A-13. Airphoto Data, July 12, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92		FM:HIE FL:P+89B		FM:IE FL:P+12		FM:EH FL:P		FM:TX FL:P+50		FM:TX FL:P+55	
		F #	SPD	F #	SPD	F #	SPD	F #	SPD	F #	SPD	F #	SPD
1128	30	1.8	1/125	11	1/250	4	1/250						
1128	4	1.8	1/125	11	1/250	4	1/250						
1130	30	1.8	1/125	11	1/250	4	1/250						
1130	4	1.8	1/125	11	1/250	4	1/250						
1131	2	1.8	1/125	11	1/250	4	1/250						
1132	3	1.8	1/125	11	1/250	4	1/250						
1134	1	1.8	1/125	11	1/250	4	1/250						
1135	5	1.8	1/125	11	1/250	4	1/250						
1138	2	1.8	1/125	11	1/250	4	1/250						
1140	3	1.8	1/125	11	1/250	4	1/250						
1140	5	1.8	1/125	11	1/250	4	1/250						
1142	1	1.8	1/125	11	1/250	4	1/250						
1205	30							5.6	1/250	4	1/250	4	1/250
1205	30							5.6	1/250	4	1/250	4	1/250
1205	4							5.6	1/250	4	1/250	4	1/250
1206	5							5.6	1/250	4	1/250	4	1/250
1210	30							5.6	1/250	4	1/250	4	1/250
1210	4							5.6	1/250	4	1/250	4	1/250
1210	5							5.6	1/250	4	1/250	4	1/250
1212	2							5.6	1/250	4	1/250	4	1/250
1213	3							5.6	1/250	4	1/250	4	1/250
1215	1							5.6	1/250	4	1/250	4	1/250
1216	30							5.6	1/250	4	1/250	4	1/250
1217	4							5.6	1/250	4	1/250	4	1/250
1217	5							5.6	1/250	4	1/250	4	1/250
1219	2							5.6	1/250	4	1/250	4	1/250

Table A-14. Airphoto Data, July 13, 1973.

TIME CDT	POND NO.	FM:TX FL:P+92 F # SPD	FM:HIE FL:P+89B F # SPD	FM:IE FL:P+12 F # SPD	FM:EH FL:P F # SPD	FM:TX FL:P+50 F # SPD	FM:TX FL:P+55 F # SPD
1414	30	1.8 1/125	11 1/250	4 1/250			
1414	4	1.8 1/125	11 1/250	4 1/250			
1414	5	1.8 1/125	11 1/250	4 1/250			
1416	2	1.8 1/125	11 1/250	4 1/250			
1418	3	1.8 1/125	11 1/250	4 1/250			
1420	1	1.8 1/125	11 1/250	4 1/250			
1422	30	1.8 1/125	11 1/250	4 1/250			
1422	4	1.8 1/125	11 1/250	4 1/250			
1422	5	1.8 1/125	11 1/250	4 1/250			
1424	2	1.8 1/125	11 1/250	4 1/250			
1426	2	1.8 1/125	11 1/250	4 1/250			
1428	3	1.8 1/125	11 1/250	4 1/250			
1429	1	1.8 1/125	11 1/250	4 1/250			
1458	30				5.6 1/250	4 1/250	4 1/250
1458	4				5.6 1/250	4 1/250	4 1/250
1458	5				5.6 1/250	4 1/250	4 1/250
1500	2				5.6 1/250	4 1/250	4 1/250
1501	3				5.6 1/250	4 1/250	4 1/250
1502	1				5.6 1/250	4 1/250	4 1/250
1505	30				5.6 1/250	4 1/250	4 1/250
1507	2				5.6 1/250	4 1/250	4 1/250
1508	3				5.6 1/250	4 1/250	4 1/250
1501	1				5.6 1/250	4 1/250	4 1/250

Table A-15. Summary Weather Data.

Date	Cloud Cover	Percent Cover	Cloud Height-Ft.	Wind
5-3-73	0	0		N-10
5-7-73	0	0		NW-8-10
5-10-73	0	0		S-12
5-16-73	0	0		W-6
5-18-73	Haze	1	25,000	SSW-10-14
5-28-73	P.C.	15	2,500	NNW-10-20
5-30-73	Haze	15	25,000	NE-9
6-6-73	P.C.	40	2,700	NNW-5
6-26-73	Haze	75	3,500	SSE-9
7-4-73	P.C.	50	4,000	SSW-8
7-5-73	P.C.-D.D.	15&30	4,500 &25,000	WSW-7
7-11-73	P.C.-O.C.	85	3,000 &25,000	WSW-8
7-12-73	P.C.-O.C.	100	4,500 25,000	WSW-3
7-13-73	P.C.	1	25,000	SW-8

P.C. = Partly cloudy
D.D. = Double Cloud Deck
O.C. = Overcast

A P P E N D I X B

FIELD SAMPLING DATA

Table B-1. Field Sampling Data

DATE May 3, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	73	0.190	N/A	N/A
2	1	72	0.120	N/A	N/A
3	1	38	0.090	N/A	N/A
4	1	37	0.275	N/A	N/A
5	1	17	0.100	N/A	N/A
30	1	68	0.080	N/A	N/A

N/A = NOT AVAILABLE

DATE May 7, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	77	0.330	N/A	N/A
2	1	68	0.215	N/A	N/A
3	1	39	0.100	N/A	N/A
4	1	38	0.180	N/A	N/A
5	1	22	0.110	N/A	N/A
30	1	66	0.305	N/A	N/A

N/A = NOT AVAILABLE

DATE May 10, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	95	0.230	N/A	N/A
2	1	70	0.140	N/A	N/A
3	1	34	0.065	N/A	N/A
4	1	37	0.115	N/A	N/A
5	1	12	0.057	N/A	N/A
30	1	60	0.390	N/A	N/A

N/A = NOT AVAILABLE

Table B-1. (page 2 of 6)
DATE May 16, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	57	0.110	N/A	N/A
2	1	50	0.085	N/A	N/A
3	1	23	0.060	N/A	N/A
4	1	31	0.080	N/A	N/A
5	1	10	0.080	N/A	N/A
30	1	51	0.103	N/A	N/A

N/A = Not Available

DATE May 18, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	65	0.175	N/A	N/A
2	1	52	0.077	N/A	N/A
3	1	21	0.045	N/A	N/A
4	1	32	0.090	N/A	N/A
5	1	9	0.090	N/A	N/A
30	1	54	0.115	N/A	N/A

N/A = NOT AVAILABLE

DATE May 28, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	200	.175	.130	95.2
2	1	45	.115	.060	32.7
3	1	18	.055	.040	9.0
4	1	27	.058	.040	8.9
5	1	11	.068	.050	10.7
30	1	55	.103	.077	15.5

Table B-1. (page 3 of 6)
DATE May 30, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	190	.137	.110	64.3
2	1	45	.090	.060	17.9
3	1	20	.140	.106	11.2
4	1	26	.085	.060	6.8
5	1	12	.053	.035	5.4
30	1	47	.040	.026	8.3

DATE June 6, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	180	.137	.070	159.5
2	1	45	.340	.280	35.7
3	1	25	.095	.070	14.9
4	1	28	.065	.030	20.8
5	1	10	.125	.085	23.8
30	1	54	.175	.150	14.9

DATE June 26, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	44	.076	.030	109.5
2	1	32	.045	.025	14.9
3	1	19	.065	.050	8.9
4	1	27	.035	.025	6.0
5	1	6	.029	.020	5.4
30	1	33	.029	.200	5.4

Table B-1. (page 4 of 6)
DATE July 4, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	355	.210	.160	119.0
	2	330	.305	.240	154.7
	3	340	.230	.165	154.7
2	1	24	.030	.020	6.0
	2	26	.055	.035	11.9
	3	26	.030	.020	6.0
3	1	15	.070	.035	20.8
	2	16	.030	.020	6.0
	3	15	.035	.020	8.9
4	1	24	.040	.020	11.9
	2	25	.055	.030	14.9
	3	24	.045	.020	14.9
5	1	8	.068	.035	9.8
	2	6	.040	.025	4.5
	3	6	.030	.020	3.0
30	1	30	.065	.050	8.9
	2	32	.050	.040	6.0
	3	30	.072	.055	10.1

DATE July 5, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	290	.510	.410	238.0
	2	285	.335	.245	214.2
	3	275	.400	.320	190.4
2	1	29	.090	.055	20.8
	2	29	.115	.075	23.8
	3	28	.080	.060	11.9
3	1	16	.055	.032	13.7
	2	16	.034	.020	8.3
	3	16	.055	.035	11.9
4	1	28	.045	.020	14.9
	2	28	.067	.030	22.0
	3	27	.060	.030	17.9
5	1	10	.080	.035	13.4
	2	6	.090	.035	16.4
	3	6	.077	.032	13.4
30	1	32	.150	.090	35.7
	2	33	.113	.067	27.4
	3	33	.130	.092	22.6

Table B-1. (page 5 of 6)
DATE July 11, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	280	.225	.177	114.2
	2	275	.155	.125	71.4
	3	285	.290	.220	166.6
2	1	27	.073	.021	30.9
	2	28	.095	.029	39.3
	3	28	.070	.025	26.8
3	1	16	.056	.027	17.3
	2	16	.042	.019	13.7
	3	15	.068	.034	20.2
4	1	24	.047	.020	16.1
	2	26	.065	.028	22.0
	3	24	.050	.020	17.9
5	1	8	.054	.020	10.1
	2	7	.060	.023	11.0
	8	7	.050	.020	8.9
30	1	29	.075	.052	13.7
	2	29	.047	.030	10.1
	3	29	.072	.048	14.3

DATE July 12, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	220	.335	.270	154.7
	2	225	.285	.222	123.8
	3	215	.560	.455	249.9
2	1	27	.112	.067	26.8
	2	27	.092	.068	14.3
	3	16	.085	.050	20.8
3	1	17	.072	.045	16.1
	2	18	.066	.038	16.1
	3	16	.085	.050	20.8
4	1	23	.066	.037	17.3
	2	23	.070	.041	17.9
	3	23	.070	.041	17.3
5	1	7	.074	.043	9.2
	2	5	.068	.037	9.2
	3	5	.080	.042	11.3
30	1	27	.095	.072	13.7
	2	27	.090	.067	13.7
	3	27	.085	.062	13.7

Table B-1. (page 6 of 6)
DATE July 13, 1973

POND NUMBER	SAMPLE NUMBER	TURBIDITY IN JTU	OPTICAL DENSITY AT: 665 nm	750 nm	CHLOROPHYLL-A IN Mg/M^3
1	1	205	.430	.340	214.2
	2	205	.360	.295	154.7
	3	185	.475	.378	230.9
2	1	23	.054	.029	14.9
	2	27	.074	.035	23.2
	3	23	.055	.033	13.1
3	1	16	.066	.024	25.0
	2	14	.042	.022	11.9
	3	14	.040	.018	13.1
4	1	24	.046	.023	13.7
	2	22	.040	.020	11.9
	3	22	.045	.023	13.1
5	1	7	.047	.020	8.0
	2	4	.067	.025	12.5
	3	4	.048	.020	8.3
30	1	28	.077	.057	11.9
	2	27	.065	.045	11.9
	3	27	.068	.047	12.5

Table B-2. Summary of Multiple Sample Field Data.

DATE	POND	TURBIDITY MEAN	TURBIDITY STD. DEVIATION OBS.	TURBIDITY STD. DEVIATION MEAN	CHLOROPHYLL MEAN	CHLOROPHYLL STD. DEVIATION OBS.	CHLOROPHYLL STD. DEVIATION MEAN
7/4	1	342	12.58	7.26	142.8	20.61	11.90
7/4	2	25	1.15	0.50	8.0	3.41	1.97
7/4	3	15	0.58	0.33	11.9	7.84	4.53
7/4	4	24	0.58	0.33	13.9	1.73	1.00
7/4	5	7	1.15	0.50	5.8	3.57	2.06
7/4	30	31	0.94	0.54	8.3	2.11	1.22
7/5	1	283	7.63	4.41	214.2	23.80	13.74
7/5	2	29	0.58	0.33	18.8	6.19	3.57
7/5	3	16	0.00	0.00	11.3	2.75	1.59
7/5	4	28	0.58	0.33	18.3	3.56	2.06
7/5	5	7	2.31	1.33	14.4	1.73	1.00
7/5	30	33	0.57	0.33	28.5	6.63	3.83
7/11	1	280	5.00	2.89	117.4	47.68	27.52
7/11	2	28	0.58	0.33	32.3	6.37	3.68
7/11	3	16	0.58	0.33	17.7	3.26	1.88
7/11	4	24	0.58	0.33	18.7	3.02	1.75
7/11	5	7	0.58	0.33	10.0	1.05	0.61
7/11	30	29	0.00	0.00	12.7	2.27	1.31
7/12	1	220	5.00	2.89	176.1	65.73	37.95
7/12	2	27	0.00	0.00	20.4	6.25	3.61
7/12	3	17	1.00	0.58	17.9	2.56	1.48
7/12	4	23	0.00	0.00	17.5	0.35	0.20
7/12	5	6	1.15	0.67	9.9	1.21	0.70
7/12	30	27	0.00	0.00	13.7	0.00	0.00
7/13	1	198	11.55	6.67	199.9	40.05	23.12
7/13	2	24	2.31	1.33	17.1	5.39	3.11
7/13	3	15	1.15	0.67	16.7	7.24	4.18
7/13	4	23	1.15	0.67	12.9	0.92	0.53
7/13	5	5	1.73	1.00	9.5	2.60	1.50
7/13	30	27	0.58	0.33	12.1	0.35	0.20

A P P E N D I X C

PHOTO DENSITOMETER DATA

Table C-1. Key for terms in Appendix C.

R1 = Red Band Color Infrared Film

G1 = Green Band Color Infrared Film

B1 = Blue Band Color Infrared Film

RC = Red Band Normal Color Film

GC = Green Band Normal Color Film

BC = Blue Band Normal Color Film

B92 = Tri-X Black and White Film
With Wratten 92 Filter

B1R = Black and White Infrared Film
With Wratten 89B Filter

B50 = Tri-X Black and White Film
With Wratten 50 Filter

B55 = Tri-X Black and White Film
With Wratten 55 and 12 Filters

* = Data Omitted Due to Unusable Ground Data

** = No Data Taken With This Film and Filter Combination

T11 = Gray Card Standardization

T21 = Grass Standardization

T22 = Concrete Runway Standardization

T23 = Blacktop Runway Standardization

Table C-2. Photo Densitometer Readings for Ponds, May 3, 1973.

POND NO.	READING NO.	R1	G1	B1	RC	GC	BC	B92	B1R	B50	B55
1	1	2.97	2.03	1.76	1.78	1.48	1.47	*	*	**	**
	2	3.00	2.05	1.81	1.78	1.49	1.47	*	*	**	**
	3	3.03	2.08	1.85	1.88	1.54	1.55	*	*	**	**
2	1	2.89	1.79	1.30	1.53	1.28	1.26	*	*	**	**
	2	2.89	1.79	1.30	1.59	1.32	1.30	*	*	**	**
	3	2.88	1.77	1.28	1.56	1.29	1.27	*	*	**	**
3	1	3.14	2.35	2.48	2.21	1.82	1.73	*	*	**	**
	2	3.15	2.35	2.45	2.23	1.83	1.74	*	*	**	**
	3	3.15	2.34	2.45	2.25	1.85	1.76	*	*	**	**
4	1	3.21	2.41	2.62	2.28	1.85	1.80	*	*	**	**
	2	3.17	2.29	2.34	2.15	1.76	1.69	*	*	**	**
	3	3.16	2.26	2.21	2.10	1.73	1.65	*	*	**	**
5	1	3.25	2.60	3.37	2.88	2.48	2.35	*	*	**	**
	2	3.25	2.58	3.30	2.86	2.44	2.28	*	*	**	**
	3	3.21	2.58	3.30	2.79	2.37	2.20	*	*	**	**
30	1	2.94	1.79	1.33	1.44	1.24	1.24	*	*	**	**
	2	2.90	1.73	1.21	1.42	1.18	1.14	*	*	**	**
	3	2.87	1.68	1.71	1.15	0.92	0.82	*	*	**	**
T11		1.42	0.71	0.46	1.38	0.99	0.69	*	*	**	**

Table C-3. Photo Densitometer Readings for Ponds, May 7, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	2.65	2.05	1.38	1.00	0.82	0.87	*	*	**	**
	2	2.65	2.06	1.41	1.03	0.85	0.91	*	*	**	**
	3	2.66	2.10	1.46	1.03	0.84	0.91	*	*	**	**
2	1	2.76	2.09	1.49	0.72	0.56	0.69	*	*	**	**
	2	2.69	1.87	1.21	0.76	0.60	0.75	*	*	**	**
	3	2.60	1.84	1.18	0.84	0.68	0.87	*	*	**	**
3	1	3.20	2.81	2.83	1.57	1.27	1.19	*	*	**	**
	2	3.21	2.82	2.86	1.58	1.29	1.21	*	*	**	**
	3	3.17	2.79	2.74	1.57	1.26	1.20	*	*	**	**
4	1	3.20	2.67	2.48	1.17	0.91	0.94	*	*	**	**
	2	3.20	2.68	2.49	1.05	0.81	0.82	*	*	**	**
	3	3.20	2.70	2.57	1.01	0.76	0.75	*	*	**	**
5	1	3.32	3.13	3.71	2.12	1.77	1.50	*	*	**	**
	2	3.33	3.12	3.71	2.11	1.76	1.52	*	*	**	**
	3	3.30	3.07	3.76	2.19	1.84	1.63	*	*	**	**
30	1	2.73	1.67	0.98	0.62	0.48	0.57	*	*	**	**
	2	2.58	1.53	0.87	0.63	0.50	0.57	*	*	**	**
	3	2.50	1.38	0.76	0.57	0.44	0.52	*	*	**	**
TII		1.21	0.91	0.46	0.61	0.39	0.30	*	*	**	**

Table C-4. Photo Densitometer Readings for Ponds, May 10, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	2.58	1.80	0.95	0.84	0.67	0.72	*	*	**	**
	2	2.55	1.85	0.98	0.90	0.72	0.78	*	*	**	**
	3	2.65	1.93	1.05	0.94	0.72	0.80	*	*	**	**
2	1	2.91	2.18	1.37	0.79	0.61	0.75	*	*	**	**
	2	2.91	1.98	1.15	0.69	0.54	0.66	*	*	**	**
	3	2.94	2.00	1.16	0.71	0.52	0.65	*	*	**	**
3	1	3.20	2.84	2.72	1.52	1.17	1.10	*	*	**	**
	2	3.25	2.85	2.78	1.52	1.18	1.12	*	*	**	**
	3	3.01	2.82	2.67	1.57	1.20	1.13	*	*	**	**
4	1	3.19	2.50	1.90	1.20	0.96	1.03	*	*	**	**
	2	3.20	2.50	1.89	1.29	1.04	1.10	*	*	**	**
	3	3.24	2.56	2.02	1.33	1.04	1.10	*	*	**	**
5	1	3.30	3.01	3.38	2.16	1.87	1.69	*	*	**	**
	2	3.32	3.01	3.31	2.16	1.88	1.73	*	*	**	**
	3	3.34	3.01	3.31	2.19	1.87	1.72	*	*	**	**
30	1	2.54	1.50	0.75	0.73	0.56	0.59	*	*	**	**
	2	2.51	1.49	0.74	0.69	0.54	0.60	*	*	**	**
	3	2.53	1.46	0.72	0.66	0.50	0.58	*	*	**	**
T11		1.10	0.85	0.41	0.56	0.37	0.28	*	*	**	**

Table C-5. Photo Densitometer Readings for Ponds, May 16, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	2.93	1.75	0.84	0.92	0.72	0.77	*	*	**	**
	2	2.94	1.78	0.86	0.92	0.71	0.77	*	*	**	**
	3	2.94	1.84	0.90	0.92	0.71	0.77	*	*	**	**
2	1	3.06	1.86	0.94	0.78	0.57	0.66	*	*	**	**
	2	3.08	1.93	0.98	0.81	0.58	0.69	*	*	**	**
	3	3.09	1.93	0.98	0.85	0.61	0.72	*	*	**	**
3	1	3.31	2.87	2.59	1.74	1.37	1.32	*	*	**	**
	2	3.31	2.87	2.58	1.82	1.45	1.39	*	*	**	**
	3	3.34	2.92	2.68	1.76	1.39	1.35	*	*	**	**
4	1	3.28	2.50	1.78	1.33	0.99	1.06	*	*	**	**
	2	3.28	2.55	1.83	1.20	0.90	1.00	*	*	**	**
	3	3.28	2.44	1.67	1.26	0.96	1.08	*	*	**	**
5	1	3.37	3.20	3.48	2.42	2.13	1.99	*	*	**	**
	2	3.38	3.25	3.60	2.32	2.01	1.85	*	*	**	**
	3	3.38	3.27	3.64	2.42	2.13	2.00	*	*	**	**
30	1	3.05	1.68	0.79	0.70	0.51	0.56	*	*	**	**
	2	3.03	1.65	0.78	0.66	0.48	0.54	*	*	**	**
	3	3.00	1.53	0.71	0.64	0.47	0.53	*	*	**	**
TII		1.28	0.75	0.37				*	*	**	**

Table C-6. Photo Densitometer Readings for Ponds, May 18, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	2.93	1.94	1.04	0.85	0.72	0.77	*	*	**	**
	2	2.94	1.95	1.05	0.91	0.77	0.84	*	*	**	**
	3	3.04	2.03	1.10	0.93	0.77	0.84	*	*	**	**
2	1	3.05	2.08	1.21	0.84	0.70	0.83	*	*	**	**
	2	3.09	2.14	1.25	0.87	0.72	0.85	*	*	**	**
	3	3.21	2.26	1.34	0.92	0.75	0.89	*	*	**	**
3	1	3.30	3.17	3.23	1.83	1.52	1.39	*	*	**	**
	2	3.30	3.19	3.27	1.85	1.55	1.43	*	*	**	**
	3	3.35	3.24	3.21	1.88	1.57	1.46	*	*	**	**
4	1	3.21	2.55	1.74	1.28	1.02	1.09	*	*	**	**
	2	3.22	2.59	1.86	1.21	0.98	1.11	*	*	**	**
	3	3.30	2.64	1.87	1.29	1.02	1.15	*	*	**	**
5	1	3.33	3.35	3.68	2.16	1.87	1.69	*	*	**	**
	2	3.32	3.36	3.69	2.20	1.92	1.76	*	*	**	**
	3	3.38	3.40	3.54	2.30	2.01	1.85	*	*	**	**
30	1	2.91	1.62	0.78	0.79	0.65	0.73	*	*	**	**
	2	2.95	1.70	0.83	0.73	0.60	0.67	*	*	**	**
	3	3.03	1.74	0.85	0.68	0.54	0.63	*	*	**	**
TII		1.64	1.15	0.56	0.60	0.42	0.34	*	*	**	**

Table C-7. Photo Densitometer Readings for Ponds, May 28, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	1.59	0.82	0.43	0.55	0.50	0.57	2.14	1.83	**	**
	2	1.62	0.88	0.45	0.57	0.52	0.60	2.13	1.83	**	**
	3	1.60	0.87	0.46	0.60	0.54	0.62	2.12	1.83	**	**
2	1	3.05	2.01	1.06	0.86	0.67	0.74	1.84	1.46	**	**
	2	c.09	2.07	1.11	0.96	0.75	0.86	1.84	1.47	**	**
	3	3.07	2.07	1.11	0.91	0.70	0.76	1.75	1.46	**	**
3	1	3.35	3.16	3.30	1.93	1.58	1.44	1.32	1.46	**	**
	2	3.36	3.20	3.44	1.97	1.63	1.48	1.32	1.46	**	**
	3	3.36	3.20	3.41	2.00	1.67	1.52	1.28	1.50	**	**
4	1	3.32	2.78	2.36	1.60	1.27	1.35	1.46	1.30	**	**
	2	3.30	2.60	1.95	1.40	1.11	1.20	1.74	1.36	**	**
	3	3.26	2.39	1.59	1.41	1.11	1.19	1.69	1.38	**	**
5	1	3.37	3.26	3.61	2.19	1.94	1.89	1.34	1.45	**	**
	2	3.37	3.24	3.54	2.09	1.81	1.72	1.21	1.46	**	**
	3	3.39	3.29	3.66	2.05	1.78	1.67	1.14	1.47	**	**
30	1	2.97	1.56	0.77	0.72	0.60	0.72	1.93	1.24	**	**
	2	2.74	1.30	0.61	0.68	0.56	0.65	2.03	1.24	**	**
	3	2.85	1.32	0.63	0.65	0.53	0.61	2.06	1.18	**	**
					TEST STRIPS						
TII		1.05	0.58	0.35	0.56	0.42	0.34		1.69	**	**
T21		1.40	1.76	1.02	1.10	0.92	0.99	1.61	1.75	**	**
T22		0.72	0.35	0.29	0.33	0.31	0.31	2.39	1.76	**	**
T23		1.49	1.09	0.76	0.77	0.55	0.45	1.95	1.20	**	**

Table C-8. Photo Densitometer Readings for Ponds, May 30, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	1.90	0.91	0.46	0.63	0.58	0.66	2.07	1.78	**	**
	2	1.89	0.90	0.45	0.59	0.56	0.64	2.05	1.76	**	**
	3	1.94	0.92	0.46	0.65	0.59	0.68	2.07	1.78	**	**
2	1	3.02	1.92	1.01	1.04	0.85	0.89	1.74	1.40	**	**
	2	3.05	1.96	1.04	1.07	0.87	0.91	1.69	1.37	**	**
	3	3.10	2.00	1.09	1.11	0.88	0.93	1.72	1.37	**	**
3	1	3.25	2.90	3.09	2.06	1.75	1.51	1.07	1.43	**	**
	2	3.26	2.91	3.15	2.07	1.78	1.55	1.06	1.41	**	**
	3	3.28	2.91	3.11	2.06	1.76	1.55	1.04	1.48	**	**
4	1	3.22	2.54	2.10	1.45	1.13	1.04	1.30	1.43	**	**
	2	3.23	2.54	2.07	1.42	1.11	1.06	1.47	1.43	**	**
	3	3.24	2.46	1.88	1.42	1.09	1.06	1.52	1.53	**	**
5	1	3.28	2.94	3.28	2.18	1.92	1.72	1.05	1.52	**	**
	2	3.28	2.94	3.34	2.18	1.94	1.78	1.10	1.53	**	**
	3	3.31	2.97	3.34	2.30	2.05	1.89	1.04	1.54	**	**
30	1	2.95	1.63	0.80	0.80	0.66	0.68	1.81	1.42	**	**
	2	2.94	1.58	0.77	0.77	0.64	0.64	1.83	1.48	**	**
	3	2.93	1.47	0.70	0.74	0.58	0.60	1.86	1.55	**	**

TEST STRIPS

		RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
T11		1.36	0.86	0.43	0.65	0.45	0.33		1.82	**	**
T21		1.55	2.19	1.44	1.38	0.97	1.04	1.63	1.94	**	**
T22		0.99	0.45	0.31	0.44	0.35	0.32	2.33	1.94	**	**
T23		1.55	1.05	0.84	0.81	0.63	0.51	1.82	1.64	**	**

Table C-9. Photo Densitometer Readings for Ponds, June 6, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	1.58	0.81	0.46	0.88	0.76	0.85	1.85	1.72	1.26	2.31
	2	1.57	0.83	0.47	0.85	0.73	0.82	1.89	1.70	1.32	2.31
	3	1.58	0.92	0.51	0.88	0.76	0.84	1.87	1.73	1.32	2.30
2	1	3.01	2.06	1.24	1.45	1.14	1.23	1.43	1.34	1.02	2.13
	2	3.01	2.06	1.23	1.47	1.16	1.26	1.44	1.33	1.02	2.11
	3	2.91	1.96	1.11	1.47	1.15	1.26	1.54	1.36	1.02	2.12
3	1	3.26	2.86	2.73	2.13	1.80	1.69	1.07	1.26	0.73	1.75
	2	3.26	2.85	2.76	2.16	1.84	1.73	1.06	1.25	0.71	1.76
	3	2.95	2.76	2.53	2.13	1.82	1.73	1.07	1.26	0.69	1.75
4	1	3.19	2.29	1.54	1.89	1.53	1.57	1.31	1.17	0.80	1.85
	2	3.26	2.62	2.05	1.81	1.44	1.50	1.11	1.20	0.91	1.94
	3	3.16	2.16	1.39	1.77	1.41	1.45	1.49	1.24	0.93	1.96
5	1	3.32	2.96	2.90	2.37	2.12	2.06	1.05	1.46	0.57	1.67
	2	3.32	2.95	2.89	2.38	2.15	2.07	1.08	1.45	0.58	1.66
	3	3.31	2.90	2.77	2.31	2.07	2.00	1.07	1.46	0.60	1.71
30	1	2.49	1.20	0.58	1.02	0.82	0.91	1.73	1.23		2.27
	2	2.48	1.22	0.60	0.95	0.76	0.86	1.78	1.23		2.27
	3	2.45	1.16	0.57	0.92	0.73	0.83	1.67	1.26		2.26
TII					0.91	0.62	0.47	1.78	1.78	1.76	2.44
T21		1.33	2.13	1.38	1.69	1.19	1.36	1.49	1.65	1.05	2.16
T22		0.80	0.39	0.31	0.73	0.60	0.54	2.13	1.72	1.71	2.58
T23		1.35	0.95	0.74	0.96	0.79	0.65	1.60	1.38	1.33	2.08

Table C-10. Photo Densitometer Readings for Ponds, June 26, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	1.22	0.80	0.63	0.94	0.86	1.00	2.26	1.76	1.95	1.94
	2	1.24	0.83	0.65	0.95	0.87	1.01	2.22	1.74	1.94	1.93
	3	1.23	0.82	0.64	0.95	0.87	1.03	2.26	1.74	1.94	1.93
2	1	2.89	2.18	1.65	1.60	1.25	1.36	1.92	1.39	1.80	1.72
	2	2.95	2.24	1.69	1.63	1.28	1.38	1.82	1.38	1.81	1.71
	3	2.98	2.30	1.76	1.67	1.30	1.40	1.72	1.37	1.80	1.69
3	1	3.16	2.98	3.36	2.19	1.87	1.72	1.51	1.39	1.61	1.39
	2	3.19	3.00	3.40	2.24	1.92	1.85	1.42	1.42	1.60	1.36
	3	3.21	3.02	3.47	2.26	1.94	1.87	1.44	1.40	1.58	1.36
4	1	3.19	2.67	2.55	1.93	1.55	1.56	1.67	1.34	1.64	1.53
	2	3.19	2.66	2.58	1.92	1.54	1.59	1.76	1.35	1.68	1.59
	3	3.18	2.70	2.63	1.90	1.54	1.60	1.65	1.34	1.67	1.56
5	1	3.34	3.34	4.31	2.60	2.33	2.16	1.03	1.28	1.39	1.01
	2	3.34	3.27	4.24	2.56	2.31	2.12	0.95	1.30	1.47	1.06
	3	3.36	3.35	4.32	2.69	2.42	2.23	0.85	1.30	1.42	0.99
30	1				1.56	1.20	1.33	1.91	1.45	1.73	1.74
	2				1.48	1.15	1.30	1.94	1.46	1.77	1.76
	3				1.41	1.10	1.23	1.89	1.45	1.75	1.74

Table C-11. Photo Densitometer Readings for Ponds, June 26, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	1.32	0.86	0.67	0.97	0.87	1.04	2.26	1.95	1.89	1.93
	2	1.34	0.88	0.68	0.98	0.88	1.05	2.24	1.78	1.88	1.93
	3	1.33	0.87	0.68	1.00	0.89	1.06	2.26	1.79	1.87	1.92
2	1	2.90	2.12	1.52	1.63	1.28	1.38	1.92	1.35	1.78	1.71
	2	2.94	2.18	1.57	1.65	1.29	1.40	1.88	1.34	1.77	1.70
	3	2.95	2.23	1.63	1.69	1.31	1.43	1.82	1.32	1.77	1.69
3	1	3.19	3.01	3.42	2.21	1.85	1.78	1.45	1.28	1.59	1.37
	2	3.20	3.05	3.58	2.27	1.92	1.87	1.37	1.26	1.57	1.34
	3	3.20	3.05	3.58	2.27	1.92	1.87	1.37	1.26	1.57	1.34
4	1	3.25	2.77	2.75	2.02	1.66	1.61	1.65	1.55	1.67	1.52
	2	3.25	2.77	2.77	2.01	1.65	1.64	1.76	1.56	1.72	1.57
	3	3.20	2.68	2.55	1.83	1.47	1.46	1.64	1.56	1.75	1.54
5	1	3.35	3.28	4.29	2.66	2.43	2.29	1.01	1.49	1.37	1.00
	2	3.34	3.25	4.27	2.62	2.40	2.23	1.02	1.49	1.45	1.03
	3	3.36	3.28	4.32	2.73	2.57	2.44	1.00	1.46	1.35	0.96
30	1	2.96	2.02	1.49	1.68	1.34	1.45	1.92	1.36	1.82	1.74
	2	2.90	1.98	1.42	1.60	1.27	1.36	1.96	1.39	1.88	1.75
	3	2.85	1.93	1.37	1.51	1.18	1.23	1.92	1.40	1.86	1.76
T11					1.08	0.76	0.58		1.66	2.28	2.03
T21					1.79	1.37	1.54	1.56	1.76	1.69	1.67
T22					0.75	0.60	0.55	2.42	1.67	2.38	2.20
T23					1.42	1.08	0.93	1.98	1.30	1.98	1.76

Table C-12. Photo Densitometer Readings for Ponds, June 26, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	1.22	0.80	0.63	0.94	0.86	1.00	2.26	1.76	1.95	1.94
	2	1.24	0.83	0.65	0.95	0.87	1.01	2.22	1.74	1.94	1.93
	3	1.23	0.82	0.64	0.95	0.87	1.03	2.26	1.74	1.94	1.93
2	1	2.89	2.18	1.65	1.60	1.25	1.36	1.92	1.39	1.80	1.72
	2	2.95	2.24	1.69	1.63	1.28	1.38	1.82	1.38	1.81	1.71
	3	2.98	2.30	1.76	1.67	1.30	1.40	1.72	1.37	1.80	1.69
3	1	3.16	2.98	3.34	2.19	1.87	1.72	1.51	1.39	1.61	1.39
	2	3.19	3.00	3.40	2.24	1.92	1.85	1.42	1.42	1.60	1.36
	3	3.21	3.02	3.47	2.26	1.94	1.87	1.44	1.40	1.58	1.36
4	1	3.19	2.67	2.55	1.93	1.55	1.56	1.67	1.34	1.64	1.53
	2	3.19	2.66	2.58	1.92	1.54	1.59	1.76	1.35	1.68	1.59
	3	3.18	2.70	2.63	1.90	1.54	1.60	1.65	1.34	1.67	1.56
5	1	3.34	3.34	4.31	2.60	2.33	2.16	1.03	1.28	1.39	1.01
	2	3.34	3.27	4.24	2.56	2.31	2.12	0.95	1.30	1.47	1.06
	3	3.36	3.35	4.32	2.69	2.42	2.23	0.85	1.30	1.42	0.99
30	1				1.56	1.20	1.33	1.91	1.45	1.73	1.74
	2				1.48	1.15	1.30	1.94	1.46	1.77	1.76
	3				1.41	1.10	1.23	1.89	1.45	1.75	1.74

Table C-13. Photo Densitometer Readings for Ponds, July 4, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	0.58	0.29	0.30	0.47	0.44	0.60	2.02	1.94	1.65	2.04
	2	0.57	0.29	0.30	0.47	0.44	0.60	2.00	1.94	1.64	2.04
	3	0.57	0.29	0.30	0.47	0.44	0.61	2.01	1.93	1.63	2.04
2	1	2.26	1.35	0.71	1.23	0.92	1.04	1.50	1.66	1.32	1.71
	2	2.31	1.38	0.72	1.25	0.93	1.04	1.45	1.65	1.31	1.70
	3	2.26	1.35	0.71	1.29	0.95	1.07	1.41	1.66	1.27	1.68
3	1	2.96	2.42	1.92	2.03	1.70	1.64	1.07	1.68	0.96	1.16
	2	2.98	2.41	1.92	2.08	1.75	1.71	1.01	1.68	0.90	1.13
	3	3.00	2.44	1.96	2.07	1.74	1.69	1.02	1.68	0.93	1.13
4	1	2.85	1.76	1.04	1.50	1.13	1.15	1.38	1.63	1.29	1.56
	2	3.00	2.01	1.27	1.46	1.10	1.13	1.40	1.67	1.29	1.56
	3	2.87	1.81	1.07	1.48	1.12	1.15	1.37	1.63	1.28	1.57
5	1	3.33	3.16	3.63	2.43	2.13	1.98	0.70	1.69	0.71	0.84
	2	3.32	3.10	3.44	2.44	2.14	2.00	0.75	1.70	0.75	0.85
	3	3.33	3.13	3.55	2.49	2.21	2.08	0.76	1.69	0.70	0.83
30	1	2.14	1.01	0.55	1.06	0.80	0.88	1.57	1.54	1.46	1.76
	2	2.37	1.20	0.64	1.04	0.78	0.87	1.54	1.56	1.47	1.78
	3	2.42	1.21	0.64	1.03	0.78	0.86	1.69	1.57	1.46	1.77
TII		0.68	0.44	0.35	0.63	0.38	0.29	1.94	1.78	2.05	2.10
T21		0.55	1.69	0.91	1.74	1.15	1.32	1.15	2.02	1.12	1.59
T22		0.47	0.25	0.28	0.44	0.35	0.32	2.15	1.92	2.00	2.20
T23		0.82	0.61	0.48	0.80	0.64	0.52	1.56	1.70	1.68	1.72

Table C-14. Photo Densitometer Readings for Ponds, July 4, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	0.33	0.25	0.23	0.79	0.74	0.94	2.17	2.07	1.51	2.05
	2	0.34	0.26	0.23	0.78	0.74	0.94	2.14	2.06	1.49	2.05
	3	0.34	0.25	0.23	0.79	0.74	0.94	2.13	2.06	1.50	2.05
2	1	1.22	0.70	0.35	1.57	1.24	1.42	1.78	1.80	1.20	1.68
	2	1.30	0.74	0.37	1.59	1.25	1.42	1.72	1.80	1.17	1.67
	3	1.40	0.80	0.38	1.60	1.25	1.41	1.64	1.81	1.14	1.64
3	1	1.78	1.54	0.78	2.21	1.94	1.88	1.28	1.81	0.88	1.25
	2	1.88	1.60	0.82	2.29	2.05	2.00	1.19	1.82	0.86	1.18
	3	2.02	1.72	0.94	2.28	2.03	1.98	1.15	1.80	0.85	1.18
4	1	1.71	0.98	0.45	1.91	1.57	1.64	1.51	1.62	1.11	1.47
	2	2.18	1.33	0.62	1.87	1.55	1.65	1.66	1.65	1.12	1.51
	3	1.81	1.02	0.46	1.94	1.61	1.69	1.53	1.63	1.12	1.48
5	1	2.97	2.46	2.04	2.61	2.54	1.42	0.86	1.78	0.53	0.75
	2	2.97	2.36	1.78	2.56	2.44	2.33	0.83	1.78	0.57	0.78
	3	3.16	2.64	2.44	2.55	2.41	2.30	0.78	1.76	0.56	0.79
30	1	1.33	0.58	0.32	1.41	1.10	1.26	1.77	1.71	1.31	1.78
	2	1.51	0.68	0.34	1.36	1.06	1.23	0.82	1.71	1.28	1.78
	3	1.44	0.64	0.33	1.30	1.01	1.19	1.83	1.74	1.30	1.79

Table C-15. Photo Densitometer Readings for Ponds, July 5, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	0.61	0.41	0.30	0.66	0.54	0.73	2.08	1.90	2.03	1.90
	2	0.62	0.43	0.31	0.66	0.54	0.73	2.07	1.92	2.02	1.89
	3	0.63	0.42	0.30	0.65	0.54	0.72	2.08	1.94	2.02	1.89
2	1	2.91	2.16	1.46	1.45	1.09	1.14	1.46	1.72	1.93	1.47
	2	2.97	2.19	1.50	1.50	1.14	1.21	1.39	1.71	1.91	1.44
	3	3.00	2.22	1.54	1.52	1.16	1.24	1.32	1.71	1.90	1.42
3	1	3.20	2.78	2.98				1.04	1.76	1.79	1.00
	2	3.24	2.83	3.12				0.98	1.75	1.78	0.94
	3	3.22	2.82	3.08				1.02	1.76	1.80	0.96
4	1	3.23	2.57	2.25	1.65	1.26	1.26	1.22	1.68	1.69	1.27
	2	3.22	2.52	2.15	1.61	1.24	1.24	1.28	1.66	1.66	1.34
	3	3.23	2.55	2.24	1.58	1.22	1.25	1.33	1.66	1.72	1.35
5	1	3.35	3.02	3.75	2.18	1.90	1.74	0.66	1.65	1.72	0.56
	2	3.35	3.00	3.67	2.18	1.93	1.78	0.64	1.69	1.72	0.55
	3	3.35	3.00	3.64	2.22	1.97	1.80	0.63	1.71	1.74	0.62
30	1	2.82	1.81	0.97	1.17	0.85	0.96	1.70	1.71	1.92	1.62
	2	2.80	1.76	0.93	1.19	0.87	1.00	1.72	1.71	1.91	1.62
	3	2.91	1.81	0.98	1.20	0.89	1.03	1.65	1.71	1.86	1.62

Table C-16. Photo Densitometer Readings for Ponds, July 5, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	0.68	0.46	0.30	0.65	0.52	0.73	2.04	1.91	2.01	1.95
	2	0.68	0.46	0.30	0.64	0.54	0.74	2.03	1.93	2.01	1.94
	3	0.68	0.46	0.30	0.65	0.54	0.75	2.04	1.94	2.01	1.94
2	1	3.06	2.24	1.62	1.33	0.97	1.01	1.51	1.64	1.94	1.60
	2	3.12	2.30	1.70	1.41	1.04	1.13	1.44	1.64	1.89	1.53
	3	3.15	2.32	1.74	1.45	1.08	1.18	1.36	1.63	1.88	1.52
3	1	3.28	2.89	3.37	1.93	1.62	1.56	0.78	1.64	1.77	1.00
	2	3.29	2.91	3.42	1.99	1.70	1.65	0.76	1.64	1.78	0.93
	3	3.28	2.89	3.37	1.95	1.66	1.60	0.78	1.64	1.77	0.93
4	1	3.24	2.58	2.33	1.58	1.19	1.17	1.27	1.43	1.75	1.34
	2	3.22	2.54	2.27	1.54	1.18	1.23	1.32	1.42	1.74	1.38
	3	3.24	2.59	2.38	1.57	1.21	1.26	1.21	1.44	1.79	1.35
5	1	3.37	3.04	3.77	2.21	2.00	2.02	0.66	1.67	1.56	0.67
	2	3.38	3.05	3.78	2.31	2.16	2.11	0.64	1.67	1.53	0.60
	3	3.37	3.03	3.77	2.31	2.18	2.21	0.63	1.67	1.63	0.71
30	1	2.92	1.92	1.09	1.17	0.84	0.90	1.81	1.37	1.88	1.61
	2	2.93	1.81	0.99	1.17	0.86	0.92	1.74	1.34	1.89	1.60
	3	2.84	1.68	0.90	1.14	0.84	0.93	1.64	1.38	1.87	1.65
TII		0.66	0.55	0.32	0.65	0.40	0.33	2.03	1.69	2.29	2.06
T21		0.45	2.30	1.58	1.70	1.30	1.67	1.12	1.84	1.52	1.46
T22		0.49	0.34	0.27	0.52	0.35	0.36	2.27	1.85	2.26	2.12
T23		0.83	0.70	0.57	0.96	0.70	0.62	1.80	1.74	2.10	1.68

Table C-17. Photo Densitometer Readings for Ponds, July 11, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	0.96	0.68	0.36	0.91	0.75	0.94	2.07	2.06	1.70	1.71
	2	0.99	0.70	0.36	0.90	0.75	0.94	2.04	2.06	1.69	1.70
	3	0.99	0.70	0.36	0.90	0.76	0.96	2.04	2.06	1.69	1.71
2	1	3.27	2.84	2.42	1.99	1.69	1.66	1.22	1.91	1.28	1.05
	2	3.27	2.83	2.36	1.99	1.68	1.66	1.20	1.92	1.29	1.03
	3	3.28	2.85	2.40	2.01	1.71	1.69	1.15	1.92	1.25	1.02
3	1	3.25	2.95	2.76	2.27	2.10	2.02	1.11	1.92	1.15	0.79
	2	3.26	2.93	2.71	2.29	2.12	2.05	1.08	1.91	1.15	0.78
	3	3.28	2.98	2.86	2.31	2.16	2.09	1.06	1.92	1.12	0.76
4	1	3.33	3.00	3.04	1.89	1.57	1.58	1.00	1.96	1.32	1.11
	2	3.33	3.00	3.02	1.74	1.39	1.41	1.08	1.96	1.39	1.19
	3	3.34	3.01	3.02	1.85	1.53	1.57	1.07	1.94	1.42	1.13
5	1	3.38	3.22	0.75	2.42	2.33	2.17	0.69	1.90	0.95	0.60
	2	3.37	3.19	3.65	2.41	2.31	2.17	0.76	1.90	1.05	0.65
	3	3.38	3.20	3.71	2.42	2.34	2.20	0.74	1.88	1.01	0.62
30	1	3.02	2.14	1.11	1.67	1.33	1.49	1.64	1.97	1.47	1.27
	2	2.95	2.07	1.05	1.73	1.38	1.52	1.68	1.97	1.49	1.25
	3	2.86	1.93	0.92	1.68	1.33	1.44	1.72	1.96	1.52	1.23
TII		0.81	0.60	0.31	1.38	0.95	0.73	1.96	2.04	1.85	1.51
T2I		0.89	2.48	1.61	2.20	1.92	2.11	1.18	2.06	0.95	0.87
T22		0.72	0.49	0.30	1.13	0.83	0.82	2.15	2.05	1.76	1.58
T23		0.93	0.72	0.52	1.61	1.24	1.10	1.73	2.02	1.39	0.87

Table C-18. Photo Densitometer Readings for Ponds, July 11, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	1.14	0.84	0.42	0.75	0.62	0.84	2.03	2.05	1.78	1.77
	2	1.16	0.85	0.41	0.76	0.63	0.86	2.02	2.04	1.77	1.77
	3	1.17	0.87	0.42	0.76	0.62	0.85	2.02	2.04	1.77	1.77
2	1	2.96	2.29	1.31	1.53	1.18	1.32	1.54	1.96	1.54	1.39
	2	2.97	2.27	1.29	1.55	1.19	1.33	1.46	1.95	1.55	1.39
	3	2.96	2.27	1.27	1.55	1.20	1.33	1.42	1.94	1.26	0.90
3	1	3.17	2.83	2.44	2.08	1.83	1.80	1.14	1.93	1.26	0.90
	2	3.21	2.88	2.58	2.10	1.86	1.82	1.16	1.92	1.25	0.88
	3	3.24	2.94	2.78	2.11	1.86	1.83	1.13	1.93	1.25	0.88
4	1	3.22	2.71	2.10	1.77	1.44	1.50	1.36	1.94	1.41	1.22
	2	3.19	2.65	1.95	1.69	1.35	1.41	1.37	1.95	1.50	1.29
	3	3.18	2.60	1.83	1.60	1.26	1.30	1.38	1.95	1.48	1.24
5	1	3.35	3.17	3.62	2.34	2.21	2.08	0.74	1.96	1.00	0.62
	2	3.34	3.13	3.46	2.33	2.26	2.18	0.75	1.96	0.98	0.61
	3	3.35	3.14	3.53	2.39	2.30	2.17	0.76	1.97	0.98	0.59
30	1	3.02	2.21	1.22	1.29	0.94	1.10	1.54	1.92	1.59	1.49
	2	2.97	2.13	1.11	1.30	0.97	1.16	1.52	1.92	1.62	1.50
	3	2.99	2.15	1.12	1.28	0.95	1.10	1.45	1.94	1.65	1.51

Table C-19. Photo Densitometer Readings for Ponds, July 12, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	0.68	0.40	0.26	0.68	0.54	0.74	2.14	1.73	1.91	1.90
	2	0.69	0.40	0.25	0.68	0.54	0.73	2.13	1.74	1.90	1.89
	3	0.70	0.41	0.26	0.70	0.56	0.77	2.14	1.73	1.90	1.88
2	1	1.85	1.46	0.59	1.53	1.15	1.28	1.76	1.48	1.70	1.46
	2	2.09	1.65	0.68	1.54	1.15	1.27	1.65	1.46	1.69	1.43
	3	2.23	1.76	0.75	1.55	1.16	1.28	1.59	1.45	1.67	1.42
3	1	2.71	2.58	1.78	2.00	1.67	1.64	1.27	1.44	1.53	1.04
	2	2.83	2.68	1.96	2.02	1.70	1.67	1.17	1.43	1.51	1.01
	3	2.81	2.67	1.96	2.02	1.69	1.66	1.21	1.45	1.52	1.02
4	1	2.94	2.22	1.17	1.85	1.53	1.64	1.49	1.24	1.54	1.24
	2	2.67	2.04	0.99	1.80	1.47	1.57	1.61	1.34	1.60	1.27
	3	2.41	1.81	0.80	1.83	1.51	1.63	1.57	1.29	1.57	1.23
5	1	3.18	3.01	3.00	2.51	2.42	2.36	0.85	1.53	1.17	0.61
	2	3.13	2.96	2.73	2.40	2.25	2.18	0.94	1.54	1.24	0.65
	3	3.19	3.02	3.02	2.48	2.36	2.29	0.84	1.53	1.19	0.59
30	1	2.69	1.57	0.62	1.44	1.09	1.28	1.73	1.25	1.73	1.59
	2	2.50	1.40	0.54	1.42	1.08	1.25	1.71	1.27	1.73	1.59
	3	2.37	1.28	0.50	1.38	1.04	1.19	1.72	1.32	1.75	1.62
TII		0.84	0.62	0.31	0.73	0.44	0.35	2.06	1.53	2.25	2.02
T2I		0.78	1.96	0.92	1.76	1.24	1.55	1.28	1.78	1.49	1.41
T22		0.54	0.28	0.21	0.55	0.38	0.37	2.25	1.72	2.19	2.05
T23		1.33	1.10	0.57	0.99	0.72	0.63	1.75	1.47	1.93	1.58

Table C-20. Photo Densitometer Readings for Ponds, July 12, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	0.70	0.36	0.24	0.73	0.60	0.84	2.17	1.77	1.93	1.90
	2	0.70	0.36	0.24	0.73	0.60	0.83	2.14	1.76	1.92	1.89
	3	0.71	0.37	0.25	0.73	0.61	0.85	2.16	1.76	1.92	1.90
2	1	2.13	1.62	0.67	1.55	1.18	1.30	1.94	1.48	1.66	1.46
	2	2.14	1.63	0.66	1.60	1.22	1.36	1.84	1.48	1.65	1.45
	3	2.06	1.57	0.63	1.62	1.23	1.37	1.70	1.47	1.65	1.45
3	1	2.64	2.45	1.53	2.03	1.72	1.69	1.36	1.46	1.54	1.04
	2	2.80	2.56	1.73	2.06	1.75	1.72	1.25	1.46	1.54	1.03
	3	2.81	2.58	1.74	2.06	1.76	1.72	1.25	1.46	1.53	1.02
4	1	2.75	2.19	1.14	1.54	1.14	1.12	1.50	1.46	1.56	1.25
	2	2.60	2.06	1.03	1.39	1.02	1.02	1.62	1.48	1.65	1.32
	3	2.50	1.98	0.95	1.47	1.07	1.04	1.63	1.45	1.61	1.25
5	1	3.22	3.02	3.02	2.19	1.88	1.77	0.77	1.43	1.07	0.58
	2	3.21	3.00	2.91	1.99	1.65	1.53	0.87	1.44	1.22	0.62
	3	3.23	3.02	3.06	2.08	1.72	1.56	0.80	1.43	1.14	0.55
30	1	2.38	1.62	0.67	1.21	0.87	0.95	1.66	1.43	1.72	1.54
	2	2.35	1.61	0.66	1.16	0.82	0.90	1.68	1.43	1.74	1.55
	3	2.29	1.57	0.64	1.11	0.78	0.84	1.72	1.43	1.79	1.58

Table C-21. Photo Densitometer Readings for Ponds, July 13, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	0.89	0.39	0.30	0.80	0.68	0.91	2.25	1.08	1.83	1.93
	2	0.88	0.39	0.30	0.81	0.69	0.93	2.27	1.07	1.83	1.93
	3	0.90	0.41	0.30	0.81	0.69	0.92	2.27	1.08	1.82	1.93
2	1	2.85	1.66	0.87	1.61	1.25	1.44	1.78	0.72	1.59	1.59
	2	2.86	1.68	0.88	1.62	1.24	1.41	1.73	0.73	1.58	1.58
	3	2.86	1.69	0.89	1.62	1.24	1.40	1.69	0.73	1.57	1.56
3	1	3.23	2.68	2.68	2.14	1.82	1.88	1.32	0.63	1.29	1.07
	2	3.25	2.71	2.75	2.14	1.82	1.86	1.27	0.62	1.28	1.05
	3	3.23	2.69	2.70	2.15	1.82	1.87	1.30	0.64	1.29	1.07
4	1	3.14	2.09	1.42	1.79	1.43	1.54	1.63	0.60	1.58	1.44
	2	3.12	2.07	1.39	1.75	1.40	1.50	1.68	0.61	1.60	1.44
	3	3.13	2.07	1.41	1.74	1.38	1.49	1.64	0.61	1.60	1.44
5	1	3.35	3.13	3.81	2.61	2.49	2.43	0.85	0.62	1.01	0.64
	2	3.35	3.14	3.83	2.59	2.42	2.31	0.83	0.62	1.03	0.65
	3	3.36	3.15	3.86	2.60	2.44	2.37	0.81	0.61	1.06	0.64
30	1	2.84	1.45	0.69	1.42	1.06	1.23	1.84	0.61	1.68	1.70
	2	2.79	1.39	0.65	1.41	1.05	1.21	1.86	0.62	1.69	1.71
	3	2.78	1.34	0.63	1.38	1.04	1.18	1.83	0.63	1.68	1.70
TII		0.65	0.40	0.29	0.94	0.60	0.47	2.17	1.17	2.09	1.95
T2I		0.63	1.91	1.05	1.77	1.24	1.50	1.49	1.32	1.51	1.56
T22		0.46	0.24	0.21	0.61	0.43	0.41	2.34	1.23	2.09	2.14
T23		0.90	0.64	0.55	0.81	0.61	0.55	1.67	0.86	1.91	1.70

Table C-22. Photo Densitometer Readings for Ponds, July 13, 1973.

POND NO.	READING NO.	RI	GI	BI	RC	GC	BC	B92	BIR	B50	B55
1	1	0.83	0.37	0.28	0.80	0.68	0.92	2.15	1.07	1.81	1.93
	2	0.83	0.33	0.28	0.80	0.68	0.92	2.14	1.07	1.81	1.93
	3	0.84	0.39	0.29	0.80	0.68	0.92	2.15	1.07	1.81	1.93
2	1	2.89	1.75	0.96	1.60	1.24	1.45	1.76	0.71	1.58	1.59
	2	2.91	1.75	0.96	1.60	1.24	1.45	1.69	0.71	1.59	1.58
	3	2.94	1.78	0.99	1.60	1.24	1.45	1.60	0.70	1.58	1.56
3	1	3.22	2.66	2.64	2.18	1.86	1.96	1.31	0.75	1.36	1.07
	2	3.25	2.69	2.74	2.21	1.88	1.98	1.26	0.74	1.35	1.05
	3	3.23	2.68	2.77	2.18	1.86	1.96	1.30	0.74	1.36	1.07
4	1	3.18	2.13	1.50	1.76	1.39	1.51	1.60	0.75	1.56	1.44
	2	3.13	2.01	1.33	1.74	1.38	1.51	1.66	0.79	1.57	1.42
	3	3.14	2.05	1.36	1.77	1.40	1.52	1.64	0.77	1.57	1.44
5	1	3.36	1.75	3.84	2.58	2.42	2.41	0.86	0.71	1.00	0.64
	2	3.36	1.75	3.84	2.57	2.42	2.42	0.84	0.69	1.03	0.65
	3	3.36	1.78	3.86	2.59	2.44	2.43	0.83	0.69	1.02	0.64
30	1	2.89	1.50	0.74	1.47	1.07	1.25	1.83	0.75	1.65	1.70
	2	2.88	1.48	0.72	1.43	1.06	1.24	1.86	0.75	1.67	1.71
	3	2.84	1.42	0.68	1.45	1.08	1.27	1.83	0.75	1.67	1.70